The BOW GROUP

Target Paper

The Case for Energy Crops

How developing countries can help themselves and boost UK energy security

A REPORT BY THE ENERGY AND TRANSPORT COMMITTEE

WWW.BOWGROUP.ORG

The Bow Group was founded in February 1951 as an association of Conservative graduates, set up by a number of students who wanted to carry on discussing policy and ideas after they had left university. They were also concerned by the monopoly which socialist ideas had in intellectual university circles. It originally met at Bow, East London, from which it takes its name.

Geoffrey Howe, William Rees-Mogg and Norman St John Stevas were among those attending the first meeting. From the start, the Group attracted top-flight graduates and quickly drew the attention of a number of government ministers, notably Harold Macmillan. In the intervening time, Michael Howard, Norman Lamont and Peter Lilley have all held the Bow Group chairmanship. Christopher Bland, the current Chairman of BT, was Bow Group chairman in 1969. In the May 2010 General Election five recent members of the Bow Group Council were elected to Parliament.

Since its foundation the Bow Group has been a great source of policy ideas, and many of its papers have had a direct influence on government policy and the life of the nation. Although it has no corporate view, it has at times been associated with views both of left and right - always within the broad beliefs of the Conservative Party.

The Bow Group (BG) has four clear objectives:

To contribute to the formation of Conservative Party policy

To publish members' work and policy committee research

To arrange meetings, debates and conferences

To stimulate and promote fresh thinking in the Conservative Party

Recent publications include:

The Enterprise Nation? Developing Northern Ireland into an Enterprise Zone

Ross Carroll with a foreword by Lord Trimble (BG Economics Committee) April 2010

The Quality and Outcomes Framework – What Type of Quality and Which Outcomes

Gary Jones, Stuart Carroll and Jennifer White (BG Health Committee) February 2010

The Right Track – Delivering the Conservatives' Vision for High Speed Rail

Tony Lodge with a foreword by Lord Heseltine (BG Transport Committee) January 2010

Telecare – A Crucial Opportunity to Help Save our Health and Social Care System

Professor Sue Yeandle with a foreword by Andrew Lansley CBE, MP August 2009

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How developing countries can help themselves and boost UK energy security

CONTENTS

A Report by the Energy and Transport Committee of the Bow Group

July 2010

Technical Acronyms

CCS	Carbon Capture and Storage
CCT	Clean Coal Technology
CEGB	Central Electricity Generating Board
CHP	Combined Heat and Power
DECC	Department for Energy and Climate Change
DFID	Department for International Development
GW	Gigawatt
LCPD	Large Combustion Plant Directive
MSW	Municipal Solid Waste
MW	Megawatt
NO_x	Nitrogen Oxide
REA	Renewable Energy Association
RO	Renewables Obligation
ROC	Renewables Obligation Certificate
ROO	Renewables Obligation Order
RTFO	Renewable Transport Fuels Obligation
SO_2	Sulphur Dioxide
TEC	Transmission Entry Capacity

Bow Group Energy and Transport Committee

The Bow Group Energy and Transport Committee is committed to researching and analysing the implications and challenges facing both sectors as a result of Government policies. The Committee regularly meets to discuss new research projects and how it can support viable, sustainable and effective policies in both of these vital areas.

Chairman – Tony Lodge
email: energyandtransport.policy@thebowgroup.org

Executive Summary

- Britain will become vastly over-dependent on one fuel for the generation of electricity by 2020 – gas.
- This gas dependency, as a result of old coal, oil and nuclear plant closures, will expose the UK to international gas price volatility in the short to medium term.
- The present world gas 'glut' will have been burned away by 2015 at the latest. This glut has kept prices down in the short term.
- Overt political, financial and structural support for intermittent renewables such as wind, as against baseload renewables like biomass, (which includes bioliquids) will exacerbate a power shortage.
- The contribution from biomass has been constrained since 2005 due to the policy environment which Government must now tackle.
- Britain needs to build a considerable 8GW of new renewable generation in under ten years to meet targets. As much of this new capacity as possible will need to be baseload or peakload renewable plant – not weather dependent intermittent supply.
- If we assume that offshore wind will deliver around 30% of capacity and that the average capacity size per turbine is 3 megawatt (MW), (1 MW delivery), we would need to site 7,000 turbines around our coast over the next 54 months
- Britain's three vital, but elderly and polluting 'peak load' oil plants must close by 2016 – they represent 3.7 gigawatts (GW) or just under 5% of UK generating plant. These should be replaced as soon as possible by low emission bioliquid renewable power plants.
- DECC is presently seeking to treat solid biomass and bioliquids differently in its review of renewable energy support – bioliquids should receive the same support as solid biomass and treated as one, as made clear by Lord Turner in the recent Committee on Climate Change report.
- The ability to trace the origin of vegetable oil from energy crops for electricity generation and consequently provide transparency and proof of their sustainability should be considered favourably in all planning applications for new power plants pledging to use traceability technology.
- Support for sustainable energy crops in developing countries will generate billions of pounds for those countries growing the crops, thus boosting Britain's overseas development policies.

Chapter 1 – Energy Generation in the UK today

Introduction

The UK currently has two parallel problems regarding present and future electricity production. Firstly, up to 40% (32 gigawatts GW) of our generating capacity is due to disappear before 2020 as fifteen of our major nuclear, coal and oil-fired stations will close on EU emissions and safety grounds[1]. Secondly, we are legally committed to generating around 34% of our electricity from renewable sources by 2020 (we currently generate just 6%).

This means the UK needs to build new cleaner generating plant that can deliver a considerable 24GW from traditional sources such as clean coal, gas and nuclear, plus an additional 8 GW of renewable electricity in just under ten years. Coupled with this are strict carbon reduction targets which mean we must reduce our emissions by up to 34% by 2020, on 1990 levels.

Past Energy Mix

The UK consumes around 325 TWh of electricity each year, generated from around 80,000-85,000 MW of generating capacity. Current supplies are provided from a portfolio of ageing conventional generation equipment, consisting of nuclear, gas, coal and oil-fired power plants.

Renewable energy sources are represented by some hydro, biomass and on and offshore wind. Historically, 75% of the UK's electricity has come from coal, oil and gas, 20% from nuclear with the balance from renewables[2].

Conventional Technology

During the last 20 years there has been a decline in the number of power plants fired by oil and coal, and a build-up of gas-fired CCGT[3] power plants due to the presence of abundant UK North Sea gas reserves, which together with those of Norway and the Netherlands, encouraged the building of low cost, high efficiency CCGT plants that could displace ageing coal and nuclear power. In the early 1990s this became known as the 'Dash for Gas'.

Coal is, in many respects, an ideal fuel for electricity generation. It is the most abundant fossil fuel and around 50% of the world's electricity is currently generated by coal-fired power stations. Global use of coal is expected to rise by

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1 EDF Energy highlights 13GW of coal and oil baseload plant which will close. Other ageing coal plant may also close by 2020 due to non compliance with the EU Industrial Emissions Directive. 7.5GW of nuclear closures are due by 2020. EDF reach their 32GW shortfall through working in with the expected closures, the expected electricity demand growth and the expected growth in renewables in line with the Renewables Obligation.

2 International Energy Agency

3 CCGT is a 'Combined Cycle Gas Turbine' – a type of generating plant in which turbines, typically fired by natural gas are used to drive generators to produce electricity.

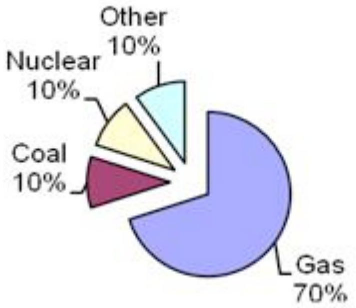
60% over the next 20 years[4]. Coal can be easily stored in large quantities, is widely available across the world and is price competitive.

In the UK, as recently as 1990, some 75% of electricity was generated from coal. Today, this dependence has reduced to 37% with gas increasingly displacing coal at 45% and rising. The negatives of unabated coal for electricity generation are the level of carbon dioxide (CO_2), nitrogen oxide (NO_x) and sulphur dioxide (SO_2) it emits. To combat this, the EU Large Combustion Plant Directive (LCPD) was put in place to decrease the amount of NOx, SO_2 and dust from combustion plants above 50 MW using solid, liquid and gaseous fuels.

Gas Overdependency

The solution, in theory, is clean coal technology (CCT) which, coupled with carbon capture and storage and more thermally efficient plant will reduce emissions of pollutants, reduce waste and increase the amount of energy gained from each tonne of fuel. In practice, CCT is still at the development stage and is expensive. It has been estimated that to fit CCS to a new coal plant could increase the capital cost by over 50%. However, without new clean coal plants the future will be hugely gas dependent. This must be avoided and a balanced energy mix supported.

Projected electricity supplied by fuel type in 2020 (terawatt hours, assuming no new clean coal)



Without CCT, the EU will not permit new large combustion plants using either coal or oil to be built and existing non-modified plants will be closed before the end of the decade. Importantly, where the UK must pay off old unabated coal plant to meet the LCPD restrictions, it is behind in its plans to replace this GW capacity by 2016 and may need to derogate from this Directive. This would be both embarrassing and controversial for the Government.

Gas-fired power stations are more efficient than older oil or coal plants. They can achieve 50% conversion efficiencies while older coal and oil-fired plants are between 30% and 49%. They are also cheaper to build and do not have the same level of emissions. However, today, the UK's gas reserves are significantly depleted and the UK is increasingly dependent on imported gas. It is estimated that by 2020 the UK will need to import 80% of its gas for electricity generation mostly from Eastern Europe and the Middle East[5]. Shale

[4] World Coal Institute
[5] 'The Energy Challenge', BERR, 2005

gas developments could lessen this dependence but this sector is still developing. By 2020, 70% of UK electricity generation could be gas fired.

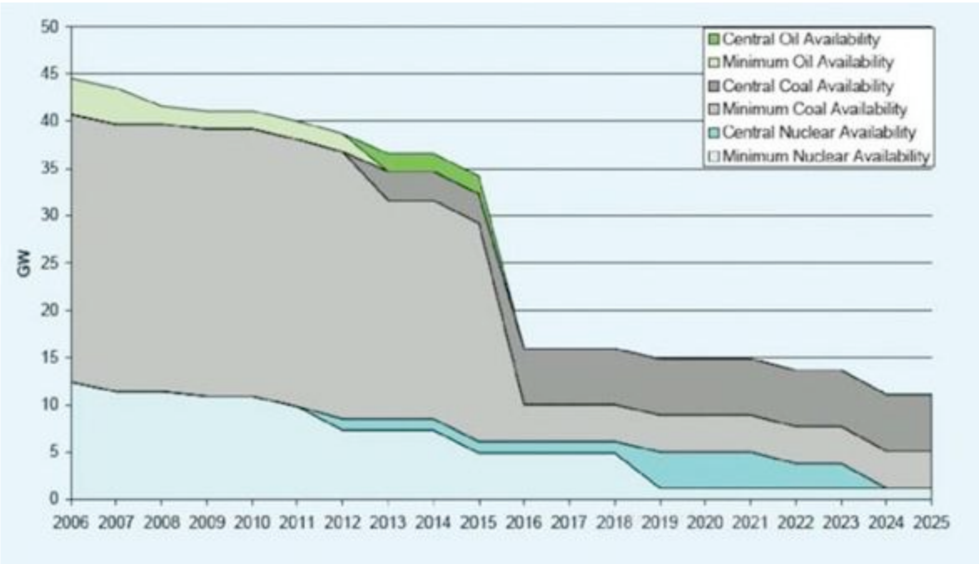
New energy statistics from the Department for Energy and Climate Change should concern those who are now in charge of energy policy. They show that although energy demand is down, due to the recession, the UK's gas import dependence rose sharply in the past 12 months.

Imports of natural gas in the first quarter of 2010 were 31% higher than a year ago. In the first quarter of 2010, and for the first time since 1968, gas imports exceeded indigenous production. Importantly, gas use for electricity generation was 18.4% higher than in the same period last year. Coal burn to generate electricity was down by 17.8%.[6]

Gas is clearly displacing coal and new nuclear is years away. Over 90% of planned and ongoing new power plant construction in the UK is gas fired.

Energy Security and Climate Change Pressures

These issues of energy security, together with the EU Climate Change Bill, have led the Government to demand that at least 30% of the UK's electricity generation should come from low or near zero carbon nuclear and renewable sources. In addition, the UK will require 24GW of new capacity brought on stream by 2025 to replace ageing units that will have to be shut (see chart below). It is important that this new capacity should be balanced and not dominated by yet more gas CCGT plant as earlier detailed.



Profile of Generation Plant Closures – EDF Energy Analysis

[6] Energy Trends and Quarterly Energy Prices, DECC, June 24 2010

Chapter 2 - How does the UK Electricity Market work?

Following the demerging of the Central Electricity Generating Board (CEGB) and the restructuring of the UK power sector in 1991, wholesale electricity was sold via a "Pool" system, whereby generators submitted offers into the Pool to supply wholesale electricity and suppliers purchased electricity from it. The arrangements for scheduling dispatch, pricing and control in the Pool was highly centralised, with most of the risks associated with these activities borne on a system-wide level by the system operator, National Grid, and the costs recovered from participants.

At that time there were only three major power producers in England and Wales, National Power, Powergen and Nuclear Electric. Over the next few years these generators were forced to sell off some assets to introduce more competition into the market. By 1999/2000, these three companies delivered only 45% of generating capacity. [7]

On the supply side, twelve Regional Electricity Companies were formed in 1991 with regional monopolies, but by 1999 it was possible for retail customers to select any UK electricity supplier, irrespective of geographic location.

The UK electricity market operates by balancing supply with demand. As there are no efficient storage mechanisms in place, it is essential, in keeping consumer prices under control, to balance the system. This is achieved by baseload and peakload generation.

Baseload generation

Traditionally, baseload generation is produced by nuclear and coal-fired plants. These stations have a high fixed cost base and run consistently throughout the year subject to planned maintenance outages. Baseload generators (particularly nuclear) can take up to one day to start up from cold and output levels cannot be easily flexed up and down to meet variations in peak demand.

These generators have a high capital cost, but low operating cost. Gas has become established as the key 'mid merit' baseload energy fuel.[8] (See chart on Generation Mix – over). One of the key requirements of the system operator is to ensure the effective management of the balance of the base and peakload generators.

Each baseload generator will be allocated a specific amount of baseload power demand to handle. The baseload power is determined by the load duration

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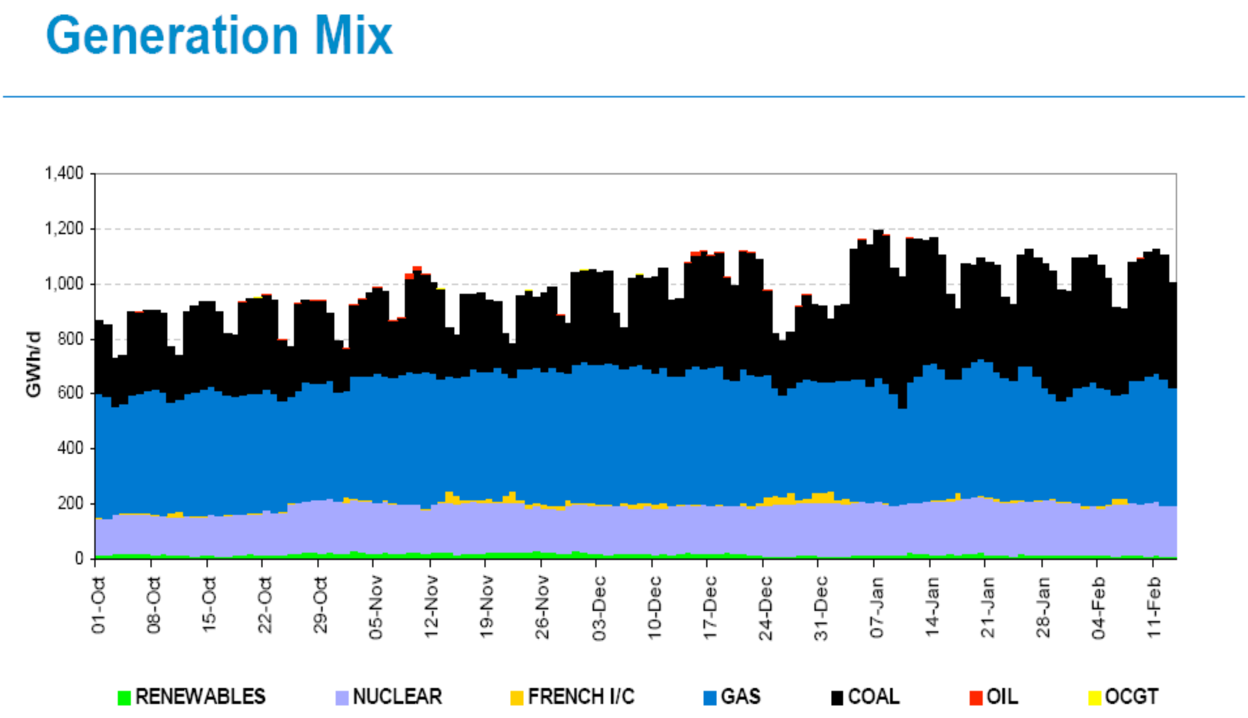
[7] UK Gas Policy, M J Parker and A J Surrey, UK Gas Policy, SPRU 1994

[8] Baseload generation is that used to meet continuous demand even at its lowest level. Non-baseload generation is brought in progressively as demand increases. Peak-load generation is used to satisfy short periods of maximum demand. Mid-merit generation is that which falls between baseload and peak.

curve of the system. For a typical power system this is usually 35 – 40% of the maximum load during the year. In the UK this is approximately 40GW. Currently in the UK the total generating capacity is approximately 78.4GW, with Transmission Entry Capacity ("TEC") 82.6GW. However, this includes full capacity for wind generation of 1.7GW.



UK Generation Mix – 1 Oct 2009/11 Feb 2010 (National Grid)

This system has a fundamental effect on pricing. In the UK there are two wholesale prices that can be achieved for electricity. One is the basic power price which relates to baseload generation and the other "prompt market" or spot price, which relates to peakload. There is no correlation between base load and spot market prices, as the markets operate independently. However, contracted sales of electricity that are sold forward effectively underpin the baseload and can be considerably lower than short-term spot prices.

Peakload supply

Peakload power stations are often smaller, cheaper to build, and more flexible when compared to baseload generators. They can be started up from cold quickly and their output can be changed rapidly. This flexibility comes at a price, as operating costs are high and the downtime is often expensive.

For these reasons, renewable energy plants are often seen as more flexible and well suited to peakload generation. This is not always the case, as wind power, for example, may not be available to meet peak demand when required. By contrast, bio-energy generation can fulfil both areas as the technology is designed to run at high levels of availability.

Intraday and day forward pricing for peak supply is generally much higher than baseload pricing, but the price achieved on any day is subject to many factors. One of the major factors that influences price is the availability of generation capacity that can be turned on at short notice. Given the shortage of efficient storage methods for electricity in the UK, additional generation capacity required at short notice will attract a significant premium compared to baseload pricing.

Margin of Supply

Also, the differential between anticipated supply and known demand can have an impact. Recently the margin between supply and demand was as little as 0.8GW, whereas this margin is usually in excess of 10GW.[9] Such a slender margin could easily be eroded with the loss of just one mid-sized power station. This set of circumstances, pushed the forward price for wholesale electricity in excess of £200 during the 2009-10 winter.

Abnormal factors

The UK is currently faced with a particular set of abnormal circumstances. Firstly, there are a number of old nuclear plants operated by British Energy in Hartlepool, Dungeness and Heysham, which have been undergoing repairs and have only recently returned to the grid. For how long these plant remain 'online' is not clear. Nearly 7GW of old nuclear capacity is expected to be retired well before 2020.

Secondly, EU rules restrict the use of some of the UK's largest coal and oil fired power stations. The EU's Large Combustion Plant Directive will close nine coal and oil power stations between 2015 and 2020, reducing available generation by over 12GW; thus reducing total generation capacity to around 68GW versus average peak demand of 62GW. Between now and these dates for closure there are strict limits on the number of hours that these plants can operate.

Importantly for peakload generation, the oil plants at Littlebrook, Grain and Fawley will also close under the LCPD. The plants represent 3.7 GW of peakload generating capacity (see page 12)

[9] A 'Notice of Insufficient Margin' (NISM) was issued twice during the 2009/10 winter.

Planned 2016 Coal and Oil Power Plant Closures under the EU LCPD

Coal Power Stations

Didcot A	2000 MW
Kingsnorth	1940 MW
Tilbury	1428 MW
Cockenzie	1200 MW
Ferrybridge C	1000 MW
Ironbridge	1000 MW
Total:	8.5 GW

Oil Power Stations

Littlebrook D	1475 MW
Grain	1300 MW
Fawley	968 MW
Total:	3.7GW

Fawley oil fired power plant on Southampton Water

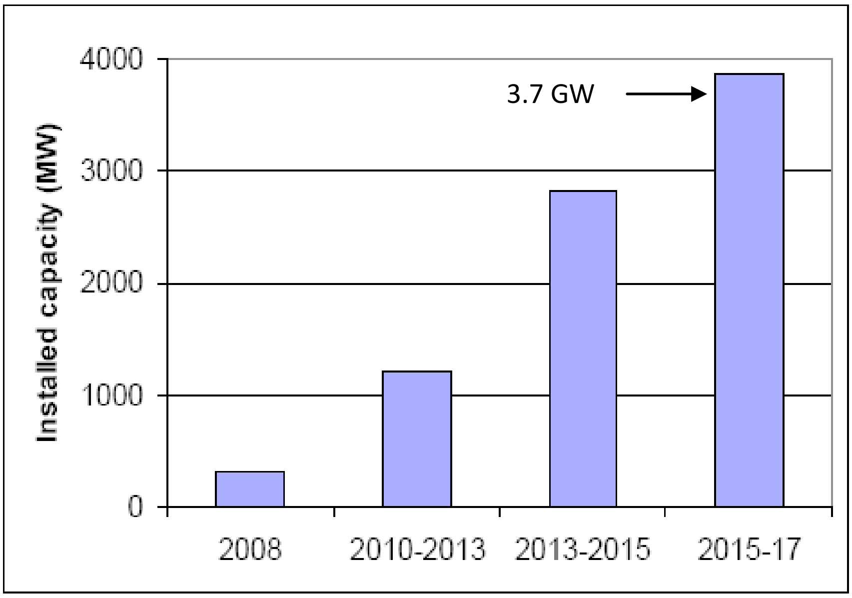
Nuclear Power Station closures expected by 2020 – non LCPD

Hinkley Point	1220 MW
Hartlepool	1210 MW
Hunterston B	1190 MW
Heysham 1	1150 MW
Dungeness B	1110 MW
Wylfa	980 MW
Total:	6.9GW

Biomass and bioliquids can replace UK oil 'peaking' plant by 2016.

This chart (right) shows the biomass electricity plant over 50MW capacity which is operational, under construction, in planning or announced as of early May 2010. Note this could amount to the vital 3.7 GW required to replace closing oil plant (above) if approvals are given and plant properly supported by DECC, including bioliquids and energy crops.

(Source – Environment Agency)



Chapter 3 - How does the Renewables market work?

Reforming the energy industry in the UK has become a high priority for Government, both to meet international climate change targets and to improve the country's security of energy supply.

Energy use accounts for around 80% of all UK emissions of greenhouse gases, represented by:

Item	Proportion
Power generation	33%
Heating	45%
Transport fuels	22%

'Meeting Carbon Budgets' – Committee on Climate Change, 2010

The Government is currently seeking to reduce UK emissions by 60% - 80% before 2050.

The UK also faces an EU target to generate 15% of all energy from renewable sources by 2020. With slow progress in heating and transport fuels, this could translate to a 30-35% proportion of electricity to come from renewable sources within 10 years.

Meanwhile, as energy consumption continues to grow the UK will also need to replace around 30-35 GW of ageing coal, oil and nuclear power stations over the next two decades to maintain adequate power supply capacity.

The Government's approach to fostering low carbon energy is based on the market delivering what is needed, prompted by incentives, tradable allowances, subsidies and environmental taxes.

The Climate Change Levy, introduced in 2001, was the first measure to target greenhouse gas emissions, through a tax on all non-domestic energy bills. Although the levy has been made neutral to business as a whole through reductions to employers' National Insurance contributions, it has seen business energy bills rise by 8% - 10%.

Since the Energy White Paper of 2003, three new significant mechanisms have been pushing the low carbon energy agenda - the Emissions Trading Scheme ("ETS"), the Renewables Obligation ("RO") and the Renewable Transport Fuels Obligation ("RTFO").

A major review of energy policy was carried out in 2006, prompted by Sir Nicholas Stern's report into the economics of Climate Change, leading to the next Energy White Paper in 2007. This set out plans for stronger action from the Government, centred around a target to move towards a 60% cut in carbon emissions by 2050, including real progress by 2020.

It included proposals to strengthen the RO scheme and set out a way forward for both renewable energy and also other alternative power technologies, including nuclear power and carbon capture and storage (CCS).

A series of Bills introduced the measures within the 2007 Energy White Paper to Parliament, including the Energy Bill, the Climate Change Bill and the Planning Bill. The UK has signed up to the EU Renewable Energy Directive and the Government has recently published the UK Renewable Energy Strategy 2009.

In January 2010 the Government announced a £100Bn Offshore Wind Farm Programme to supply up to 30GW capacity.

Market delivery and RO mechanism

The underlying delivery structure is here set out. In effect suppliers have to deliver the required level of renewable energy to consumers, as evidenced by ROCs, such ROCs either having been provided by renewable energy generators in their sales to the suppliers, or by acquiring ROCs in the market if the supplier has not sufficiently met its obligations.

Under the Renewables Obligation, electricity suppliers must source an increasing percentage of the electricity they sell from renewable generators each year. In England and Wales, the obligation is currently to provide 10.4% of electricity from renewable sources in 2009-10, rising to 15.4% in 2015. Scotland has its own RO system, with targets to supply 18% of electricity from renewables this year. Suppliers meet this obligation by purchasing electricity from an accredited renewable generator, and they receive a ROC for each MWh of energy purchased.

Renewables Obligation Certificates ("ROC")

A ROC is a green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. The numbers of ROCs issued per MWh are subject to a banding system that was implemented in the Renewable Obligation Order 2009 ("ROO") which became law in April 2009.

The ROO places an obligation on licensed electricity suppliers in England and Wales, to source an increasing proportion of electricity from renewable sources. In 2009-10 the obligation is set at 10.4%.

However, it is only those players in the energy market with end-user customers of their own (whether commercial or domestic) who can physically cash in their ROC certificates. If an energy provider fails to generate the required percentage of renewable energy itself, then it must buy the energy from someone who has. The ROC is the proof of generation which is passed to the purchaser (the energy provider). Due to their great demand, ROCs are traded on the open market and sold to the highest bidder. If a company fails to generate the required percentage of renewable energy, or buy the appropriate amount of ROCs, then fines can be imposed.

A Market Place for ROCs

There is a market place for the trading of ROCs between electricity suppliers and renewable energy generators. One such organisation is the Non-Fossil Purchasing Authority Ltd. They run a series of on-line auctions which enable obligated suppliers to purchase ROCs from renewable energy generators.

The ROCs are transferable between generators and suppliers at market rates. Non compliance by the electricity supply companies results in penalties referred as the "buy-out" rate. This is set every year by Ofgem. In 2009/10 it is £37.19. These are paid into a buy-out fund.

The penalties paid at the buy-out rate into the buy-out fund by non-compliant suppliers are shared among those compliant suppliers in proportion to the percentage of ROCs they hold. Consequently, there is this extra incentive for suppliers to achieve their targets as this attracts a share in the penalty dividend. It also increases the market trading value of the ROCs.

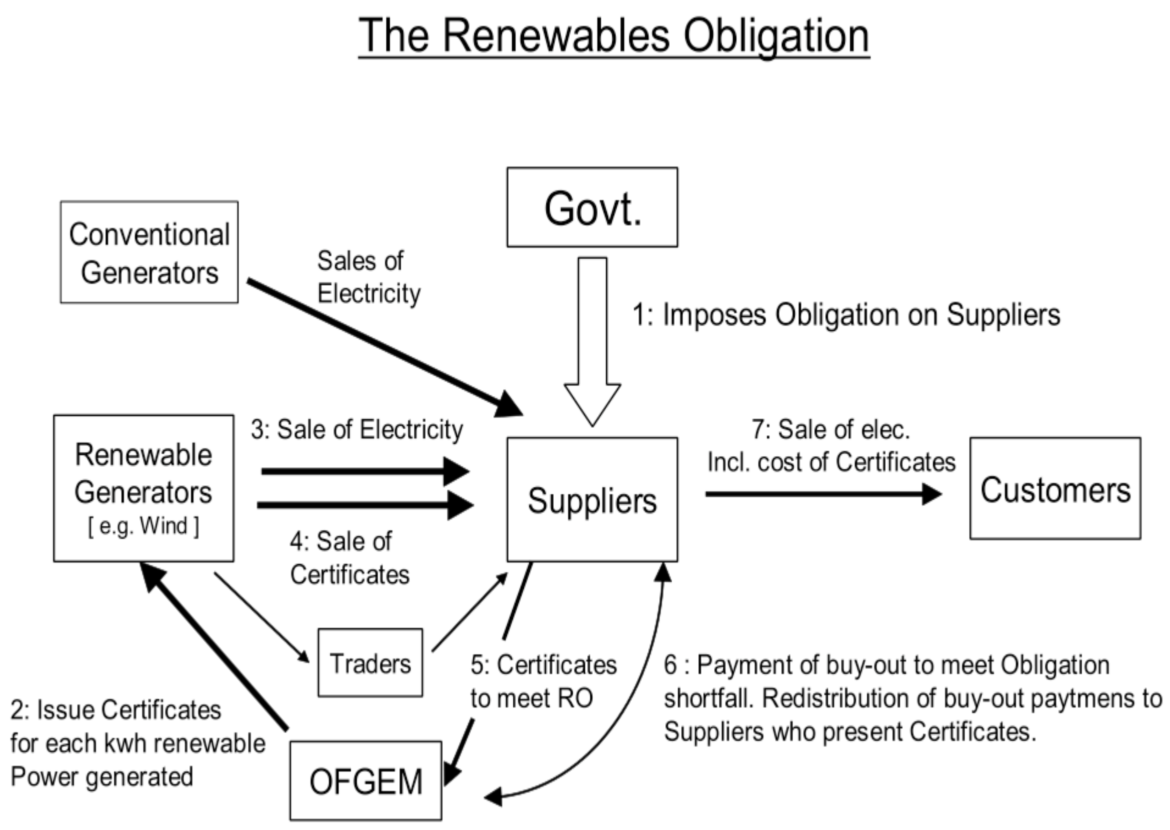
Although the buy-out rate is set by Ofgem (2009/10 £37.19), the market value of ROCs also includes the value of a share of the penalties. Electricity suppliers holding ROCs will be entitled to a share of the penalty payments made by those suppliers who fail to hit their target. Consequently, the trading value of a ROC combines the penalty value and the additional premium from the sharing of the penalties paid by other suppliers.

Auction prices peaked at £53.27 per ROC in July 2008 and have averaged £51.16 throughout 2009. This represents an average premium of £13.97, which is effectively the markets assessment of the penalties dividend for the year.

Each year, suppliers have to balance the costs of investing in renewable electricity generating capacity; contracting to buy ROCs from independent generators; trading ROCs in the market place; or paying penalties to reach the specified minimum of ROCs required for their total output.

Drivers that shape ROCS

There are a number of drivers that shape the traded price of a ROC. The amount of renewable energy that is required increases through the ROO each year.



Each supplier accumulates ROCs and uses them to demonstrate to Ofgem that it has complied with its annual obligation to purchase renewable electricity. If the supplier does not have sufficient ROCs at the end of the accounting period, it has two options:

- Option 1 – the supplier can purchase ROCs in the market from independent traders or suppliers who may have excess ROCs
- Option 2 – the supplier can pay a "buy-out" price to Ofgem to covers its shortfall

While the price of each MWh of renewable electricity remains pegged to the wholesale price of electricity, the price of ROCs sold by generators is related to their availability compared to demand. If the UK is a long way off its annual renewable electricity targets, ROCs will be expensive, but if the UK is meeting or exceeding its annual targets, prices will be generally low.

The buy-out mechanism enforces a cap on ROC prices. The buy-out fee, which is effectively a fixed penalty for not meeting Government targets, is set by Ofgem based on its forecast for the issuing of ROCs in each year.

The total buy-out fees gathered each year by Ofgem are then shared out among those companies who have already presented ROCs to Ofgem - acting as an incentive to companies to buy ROCs, rather than opt for the buy-out option.

The system includes a cap on co-firing – (the burning of biomass material along with fossil fuels in power stations such as coal) - which effectively means co-firing ROCs have a different, lower price than regular ROCs.

Missing Renewable Targets

The Government has recognised that it was unlikely to meet the UK's renewables targets, as originally anticipated. As a result, it has reformed the RO system via the Energy Bill, notably by introducing a new banding mechanism for the issuing of ROCs.

From 1 April 2009, this provides greater financial support to new and underdeveloped renewable energy technologies, and less support to commercially established technologies. For example, cheaper, established technologies like landfill gas will receive less than one ROC per MWh of energy generated.

More expensive, less established technologies, such as gasification, tidal and offshore wind power, will receive more than one ROC per MWh of energy generated.

Band	Technologies	ROCs per MWh
Established	Sewage gas; landfill gas; co-firing of non-energy crop (regular) biomass	0.25
Reference	Onshore wind; hydroelectric; co-firing of energy crops; Energy from waste with combined heat and power[10]; other not specified	1
Post-demonstration	Dedicated regular biomass	1.5
Emerging technologies	Offshore wind; Wave; tidal stream; advanced conversion technologies (anaerobic digestion, gasification and pyrolysis); dedicated biomass burning energy crops (with or without CHP), dedicated regular biomass with CHP; solar photo voltaics; geothermal	2

The new bands will be reviewed every four years, to make sure that they encourage worthwhile new technologies and do not provide excessive support to established generation methods. The next review will be in 2013.

[10] CHP - Combined heat and power is the simultaneous generation of heat and electricity, typically where the need for both arises for industrial or commercial purposes

Chapter 4 - The Renewables Dilemma

The ideal means of generating renewable electricity is clearly via a delivery system that does not require fuel. This is why wind, tidal and wave technologies come top of every green list. However, the dilemma is that these technologies are less good at actually meeting the practical requirements of the UK's short term renewable electricity target (15.4% by 2015) and up to 30% and beyond by 2020.

Firstly, wave and tidal technologies are still in their infancy and deep water off - shore wind, the UK Government's preferred choice, is still at an early stage of development. Even when in place, each turbine, which needs a special platform (of which only a handful are currently available), to enable it to be sunk deep into the sea bed, will have a capacity of perhaps 3 MW but will actually deliver power of around 1 MW.

If 1,000 new off-shore wind turbines are constructed between now and 2015, (a most unlikely scenario due to infrastructure support and planning constraints,) this would create 3 GW of capacity and actually deliver around 1GW to the grid (see 'Wind' below). Given that we need an additional 8GW of renewable electricity by 2020 to meet our legal and binding target this leaves the UK well short of targets.

So how do we get there?

The new Coalition has confirmed that it wants to obtain at least 15% of its electricity from renewable sources by the middle of this decade (we presently generate around 6%). That is in about four and a half years. This means we need to build up to 5GW of renewable capacity in 54 months.

This requires analysis of the alternatives available and the placing of realistic figures against each technology as a contributor both to our short term target and to the longer term (post 2020) market.

Wind

The Government has stated a strong preference for the wind sector to expand its activities in the offshore sector. It has publicly stated that it expects in excess of 30 GW to come from offshore wind in the next fifteen years.[11]

The first point which must be clarified before assessing the potential size of the offshore wind market, is the difference between capacity and delivery. Capacity is the generation figure that a wind turbine will generate if it is operating 24 hours a day, 365 days a year. Delivery is the actual generation received by the grid, which is very different. Wind turbines do not deliver

[11] Utility Week – February/March 2010

electricity when the wind is too strong or when it blows too lightly. The actual performance data for 2009 suggests that wind currently contributes around 33% of current renewable power to the grid.

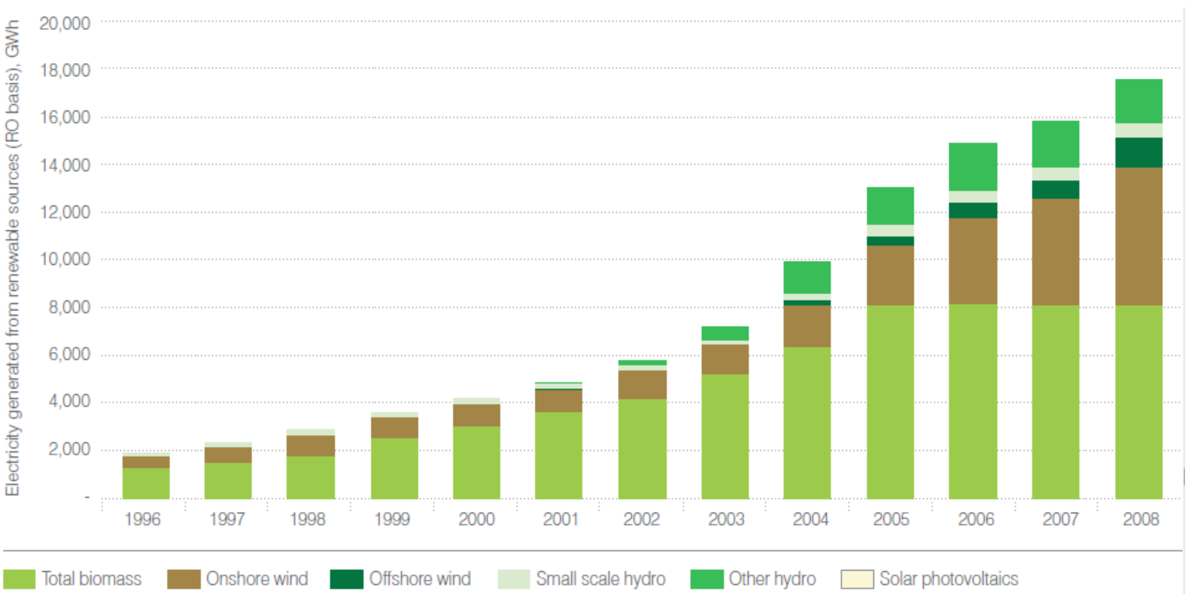
If we assume that offshore wind will deliver around 30% of capacity and that the average capacity size per turbine is 3 MW, (1 MW delivery), we would need to site 7,000 turbines around our coast over the next 54 months. This would require 32 turbines to be built each week which is an extremely difficult target.

Furthermore, undertaking all of our short term renewable energy via wind would create issues for the National Grid because of the uncertainty of winds' delivery pattern. A reasonable assumption would be for 25% of our increased renewable target to be met via offshore wind. This represents 1,750 new turbines being commissioned by the end of 2014; a major task given the time frame for turbine and blade construction and the limitations regarding the number of available platforms for sea bed preparation and siting.

A Proven Renewable

Biomass is a proven renewable technology which can play a significant role in achieving the UK's renewable targets and $C0_2$ emissions reductions targets of 34% on 1990 levels by 2020 and at least 80% by 2050.

As shown in the chart below, under the Renewables Obligation, biomass has contributed more electricity than any other renewable for the entire period 1996 to 2008. However, the chart also shows that the contribution from biomass has been constrained since 2005 due to the policy environment which Government must now tackle.



Source: Digest of UK Energy Statistics, 2009

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%, with 10% downtime for maintenance. The intermittent nature of other renewable technologies leaves them trailing.

Nuclear

While nuclear cannot be referred to as renewable it is a major contributor to reducing green house gas emissions. It is therefore important we assess the likely future role for nuclear energy.

For the last twenty years, successive governments have sat on the fence regarding the replacement of the UK's ageing nuclear plants. It took until 2006 for the then Prime Minister, Tony Blair, to tell Parliament that "in common with countries around the world, we need to put nuclear back on the agenda and at least replace the nuclear energy we will lose" (*as old plants are closed*).[12]

The 2007 Energy White Paper noted that security of supply was now a major challenge and that rising fossil fuel prices coupled with costs on carbon emissions had changed the economic picture for clean energy generation. It proposed stronger international and UK constraints on carbon emissions, more efforts on energy conservation and greater support for renewables – rising to £2 billion a year. It also gave clear support for investment by the private sector in nuclear power capacity, so that nuclear could play a significant role in the UK's energy future.

By the end of 2009, this support for nuclear had become part of the National Policy Statements on energy policy to 2025. Nuclear power is central to these and, from about 2017, the plan was that ageing plant, both nuclear and other, would be replaced by private investors as part of a trinity of low carbon technologies: renewable, nuclear and carbon capture and storage (CCS).

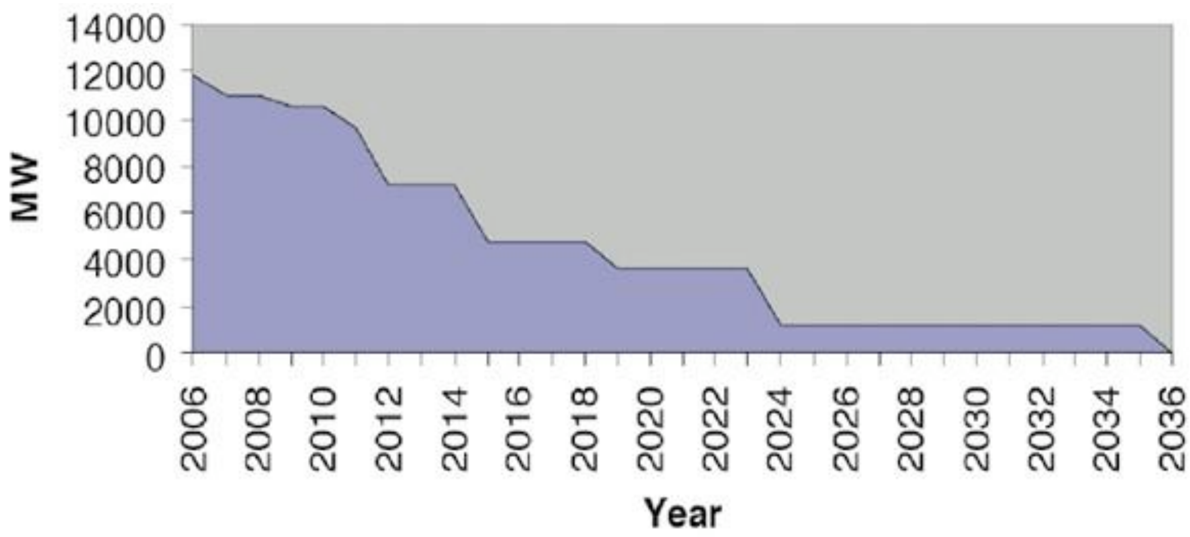
A new planning regime was proposed to aid the installation of nuclear reactors as well as large offshore wind farms and their transmission lines. The key change was that local hearings will debate local issues and not question the national infrastructure needs or the virtues of the technologies proposed. These issues were to be handled by an independent Infrastructure Planning Commission (IPC) taking guidance from these National Policy Statements once they had been approved by parliament.

The companies likely to be involved in the construction of new nuclear plants either individually or in partnership, include EdF Energy, RWE Npower, E.ON, Iberdrola and GDF Suez. The key question is how soon these plants will be up and running.

[12] Statement by the Prime Minister, Hansard, June 23 2004 – Col 324

EdF is planning to build four large new EPR nuclear reactors totalling 6.4 GW at Sizewell in Suffolk and Hinkley Point in Somerset. Planning applications are expected to be submitted around mid-2011 when the regulatory process on reactor design will finish and EdF is hopeful that they will be commissioned by the early 2020s.

This still leaves a considerable gap in capacity as old plant disappears and new plant arrives. Without swift approval for new nuclear the lack of new nuclear capacity from the early 2020s is a cause for deep concern (see chart below)



Current expected decline in nuclear capacity in UK generation, DTI, 2005

RWE and E.ON are planning to build some 3.3 GW of new nuclear capacity at Wylfa in Wales and a further 3.3 GW at Oldbury in Gloucestershire. Planning applications for these sites are expected to be submitted later (Wyfla in 2012 and Oldbury in 2014) and it is unlikely that either of these sites will be commissioned before 2020 at the earliest, again exacerbating the energy gap.

This suggests it is likely there will be a gap between the de-commissioning of existing nuclear plants and the commissioning of new ones. This 10+ GW gap could stretch from 2016 to 2020 or possibly longer.

Waste to Energy

The main incentive to looking at better methods of disposing of municipal solid waste (MSW) is that historically, the vast majority has been tipped into landfill sites where, as the biomass element of the waste decomposes it releases methane gas. Every metric ton of municipal solid waste (MSW) produces approximately 62 cu metres of methane, caused by anaerobic digestion. If this gas escapes into the atmosphere it has been argued that it has more than twice the global warming potential than a metric tonne of CO_2. However, if it can be captured, the gas can be used to power turbines and generate renewable energy.

The negative of nearly all current thermal waste to energy technologies, which includes incineration, is that most of the carbon content of the waste used to generate electricity is emitted as CO_2.

However, Anaerobic Digestion technologies which use the biomass content of MSW to create methane to generate electricity are strongly supported by most EU countries and the UK has placed AD as the beneficiary of 2 ROC banding.

Gasification, also a 2 ROC banding recipient is a thermal-chemical process in which the waste biomass is heated in an oxygen deficient atmosphere to produce a low energy gas which is then used to fuel a turbine or combustion engine to generate renewable electricity.

Pyrolysis is an advanced conversion technology that has the ability to produce a clean high calorific value gas from a wide variety of waste and biomass streams. The hydrocarbon content of the waste is converted into a gas which can power a turbine for renewable electricity generation. Pyrolysis also benefits from 2 ROC banding.

These latest waste to energy technologies, while at an early development stage, will make a major contribution to renewable electricity production in the next ten years.

Wave and Tidal

There is no doubt that wave and tidal technologies are also developing fast, their research and development focus being in Scotland and the South West.

The British coastline is 11,077 miles long with high tidal ranges including the Severn Estuary, the second highest in the world. If barriers are created across major estuaries such as those found at Humber, Dee, Severn, and Solway the volume of water moving up and down these estuaries is more than sufficient to drive turbines embedded in the barriers to great effect. A recent design for a barrage across the Severn Estuary suggested that it could generate up to 4 GW of new power to the grid representing around 5% of the UK's total energy needs.

However, there are major environmental issues. While they can clearly make a major contribution to greenhouse gas savings these estuaries are among the world's most productive and sensitive ecosystems and the flooding caused by these barrages causes a great disruption to their natural processes. For this reason, gaining local planning consent can be a major issue.

Tidal technology has been pioneered in Scotland where the European Marine Energy Centre has been established and, again, the expectation is that within the next ten years, significant amounts of tidal generation will be available. However, for the next ten years it is unlikely that more than a few hundred megawatts of tidal power will be available to the grid.

Solar

The UK Government is supporting the development of solar energy for electricity generation offering individual householders up to £3,500 towards the cost of solar installation plus a feed-in tariff that guarantees payment for 25 years and offers up to 41.3p per kw/h for electricity that is exported to the grid.

The downside is that the weather in the UK will not deliver the same amount of solar energy as is generated in countries closer to the Equator. However, the new feed-in tariff structure, introduced in April this year, is likely to encourage significant growth for both solar installations and for micro wind generation.

Chapter 5 - The Potential of Energy Crops

Biomass and energy crops represent one important obvious solution to the UK's short to medium term energy needs. The difference between the two categories is that biomass as a term includes any fuel, liquid or solid, coming from plant sources. Unsustainable palm oil, as an example, would be included in the biomass category.

Energy crops as a definition ensures that the crop was planted and grown specifically for energy purposes.

Power plants fuelled by energy crops is a fully proven technology. They can be built within a two year period and there is currently sufficient sustainable solid and liquid fuel to deliver 2 GW of renewable base load electricity by 2015. This represents over half of the capacity being lost with the paying off of peakload oil plants by 2016. Longer term, new fully sustainable sources of fuel can be developed in some of the neediest parts of the world to provide the UK with as much renewable and sustainable fuel as it needs.

The main developers of renewable electricity from plant sources in the UK today are E.ON, Helius Energy, Drax and RWE, all of whom are proposing to use woodchip to fuel plants from 150MW to 350 MW. The vast majority of the woodchip fuel for these plants will be imported by ship from Eastern Europe, Canada and South America. It is not yet clear whether this fuel will fall under a definition of energy crops given that some of the wood used will come from waste resulting from wood used for other purposes. In the longer term it may become necessary for these developers to source crops that can be identified as fully sustainable and grown for purpose.

Energy Crops and Sustainability

Sustainability is a key issue for energy crops. Issues of de-forestation, change of land use, carbon storage via peat land and wetland has created concerns that the growing of any form of crops for energy use could actually have a negative effect on greenhouse gas emissions.

The EU Renewable Energy Directive has produced perhaps the most comprehensive definition of sustainability for energy crops. This very clearly lays down guidelines for anyone wishing to grow or use energy crops as feedstock for electricity generation.

The key areas of the definition are as follows:

- The greenhouse gas emission savings from the use of energy crops versus fossil fuels should be at least 35%
- Energy crops should not be grown on de-forested land
- Energy crops should not be grown on land with high biodiversity

- Energy crops should not be grown on peat land or wet land.
- Energy crops should not be grown on land used for food production.

A leading developer of renewable electricity plants fuelled by liquid energy crops in the UK is W4BUK. It has adopted the EU Renewable Energy Directive definition of sustainability, despite the current UK sustainability requirements being less stringent, and is planning to ensure that all its feedstock purchases meet these criteria and can be proved to do so. To this end it plans to use traceability technology, developed by a Johnson Matthey subsidiary, that will "fingerprint" every tonne of oil it uses and allow it to be traced back to its plantation source.

No deforestation

Assuming there is no de-forestation or change of land use, biomass and energy crops from Asia, Africa or South America will deliver significant greenhouse gas emission savings versus fossil fuels.

There is another argument put forward against using biomass or energy crops for electricity generation. This is that any unused land in developing countries should grow crops for food not fuel. Clearly, no-one will argue it is right for forests and peat land to be sacrificed to create new sources of fuel for energy production. Nor should anyone argue that land currently producing food should be converted to fuel production. However, there is an enormous amount of unused savannah land and eroded land that can be put to positive economic use to improve the living conditions of some of the poorest people in the world.

Companies which are involved in energy crop cultivation have an active interest in ensuring sustainable farming practices are implemented in the countries they invest and set up in. UK company, Carbon Credited Farming (CCF), for example, has set up nurseries only on land which has secondary forest growth and plants a variety of crops, therefore avoiding a mono-crop culture. In addition plantations are also planted with food crops, therefore providing other possible means of revenue. The company has licenses across a portfolio of lands to also develop them for sustainable lumber as well as the conservation of virgin forest.

Responsible use of land

A large number of its contracts are in areas which are suffering the effects of illegal logging, therefore responsible use of the land for economic reasons is of great benefit. Other benefits extend to CCF training and educating farmers on the importance of planting a variety of crops to avoid land degradation and provide better yields amongst other responsible farming techniques.

Importantly, this land is not currently used to produce food. Where land capable of sustaining crops remains unused it can be assumed that a country is already growing sufficient food on other land to feed its people.

How can we be sure?

How can we be sure and guarantee that the vegetable oil from energy crops comes from this land and not from land that has involved de-forestation? British companies like W4BUK, which plan to build two bioliquid power plants in Bristol and Portland, have pledged to use technology which will be able to identify the plantation from which every tonne of imported vegetable oil has come from. This British traceability technology will also allow governments to create and enforce stronger laws for the protection of forests and peat lands in developing countries.

To demonstrate the scale of this project, generating sufficient vegetable oil to provide the UK with 2 GW of renewable electricity from energy crop plants requires approximately 2.1 million hectares of land under production. To put this in perspective that represents 3% of the land mass of Mozambique. Such a project can generate over £1 billion annually for those growing the crops and thus help alleviate poverty and unemployment.[13]

DECC and DFID interest

Growing a range of energy crops including jatropha[14] and castor on this land can lift people out of economic poverty and provide them with a new revenue source that will improve their overall quality of life, and help in the battle against climate change. Importantly, the UN has concluded that climate change will affect the world's poorest countries first and hardest due to the vulnerability of infrastructure and eco-systems. This also provides the UK with both a DECC and DFID[15] interest in the development of sustainable energy crops.

Traceability technology

W4BUK believes that traceability technology for both solid and liquid energy crops should be adopted as a part of the EU sustainability criteria as it will remove any doubt as to source of feedstock and address critics who have rightly questioned and investigated the sustainability of energy crops.

13 MAN Group state that a 50MW plant running for 8,000 hrs will need 85,000 tonnes of oil per year. Thus to produce 2 GW will require 85,000 x 40 = 3.4 million tonnes. Average yield for Jatropha oil is 1.6 tonnes per hectare. Therefore you need 2.1 million hectares to grow 3.4 million tonnes. Total land mass of Mozambique 80,159,000 hectares thus 2.1 million = 2.6%. Re Revenue 3.4 million tonnes of oil per year providing farmers with $450 per tonne = $1.53 billion = £1.02 billion

14 Jatropha is a hardy plant that is resistant to drought and pests, and yields seeds that contain 27 to 40% oil.

15 DFID – Department for International Development

These two examples demonstrate how energy crop sustainability can be both boosted and guaranteed, in line with the Government's new palm oil research project, announced in July 2010.[16]

Subsidies and Grandfathering for Energy Crops

The opportunity for investors and bank lenders to support this vital sector of the renewable industry depends on two issues; ROC banding and grandfathering[17]. The current UK ROC banding system allows 2 ROCs for "dedicated biomass burning energy crops (with or without combined heat and power CHP)." Dedicated regular biomass receives 1.5 ROCs. This banding remains in place until it is reviewed in 2013.

The issue of grandfathering is currently under review and until this is resolved it will be difficult for companies to secure funding. Both equity investors and those banks being asked to provide senior debt will be looking for the certainty that grandfathering offers.

DECC is currently undertaking a consultation process on the grandfathering policy of support for dedicated biomass, though its current evaluation differentiates between biomass as a category and treats energy crops as a quite separate category. DECC is proposing that solid biomass for electricity generation should be grandfathered, bioliquids (an EU definition of liquid fuel, from biomass, for energy purposes other than for transport) should not be grandfathered and energy crops should be grandfathered.

Furthermore, in creating their division between solid and liquid biomass DECC has chosen to re-define the current biomass definition as used by the Committee on Climate Change, set up by DECC, in their latest report published at the end of June. This states in its definition section that Biomass is "biological material that can be used as fuel or for industrial production. Includes solid biomass such as wood and plant and animal products, gases and liquids derived from biomass, industrial waste and municipal waste."[18]

Government contradictions on Biomass

This contradiction is difficult to accept. There is much to agree with the Renewable Energy Association, who in their response to DECC, have made the point that such a ruling would not only be unfair and discriminatory but would hugely complicate the re-drafting of the Renewables Obligation. One of the issues is that it is almost impossible to differentiate between liquids and solids as one form can actually be converted into another. Furthermore, certain crops have a solid and liquid element (palm oil and jatropha as examples). Finally,

[16] 'Palm Oil research project launched by Government,' BBC News, July 13 2010
[17] 'Grandfathering' refers to the locking in and continuation for a prolonged period of ROC allowances
[18] Meeting Carbon Budgets – Ensuring a Low Carbon Recovery, June 2010 (Committee on Climate Change)

the same crop can meet the criteria for more than one category. Jatropha as an example meets the criteria for both a bioliquid and an energy crop.

The REA also believes the proposal to split the ROC benefit into fixed and variable amounts, with the former grandfathered and the rest being able to react to fuel prices would be an elegant solution were it possible to implement but the REA's membership suggest it is unworkable.

If the reason for DECC's concern regarding bioliquids is the question of sustainability then this issue is fully covered in Article 17 of the EU Renewable Energy Directive which would prevent support, whether ROCs or grandfathering being given to plants using fuels that were "unsustainable".

Conclusion

The new Coaltion Government risks an energy crisis towards the end of its five year fixed term, in 2015, unless it moves to guarantee and support new baseload renewable power plants alongside other diverse new build.

Alongside the closure of Britain's old coal and nuclear plants are the three vital oil plants, which have helped the UK avoid electricity generating 'gaps' in recent winters as they meet 'peakload' supply at times of high energy demand.

If the UK Government wishes to encourage a further 8GW of renewable electricity by 2020, it should make certain that it looks favourably on proposed renewable baseload generating plants proposing to use sustainable energy crops, both liquid and solid. Wind's intermittent energy delivery means baseload renewables are vital.

This policy support should maintain ROC support and grandfathering to encourage investors and banks to put their weight behind perhaps the only renewable category that can meet our 2015 target of delivering 15.4% of our electricity from renewable sources, slash carbon emissions from the electricity generating sector and help avert an energy gap.

The ability to trace, and consequently guarantee the sustainability and proper use of land to grow energy crops overseas can and should be heralded as a benchmark standard for all energy crop production, in order to prevent and stop the logging and deforestation activities associated with some palm oil operations and energy crops operations. The Government would be wrong not to 'grandfather' bioliquids for use in electricity generation. This will cause renewable targets to be missed.

Energy crops are a reliable and vital renewable. New tracing technology to authenticate their sustainability allows critics' accusations to be met and addressed. They can fill the gap left by Britain's soon to close oil plants and should be supported.

By supporting the sustainable growth of energy crops in developing countries the UK can boost its overseas development policy, boost an ailing renewables sector at home and help meet ambitious carbon reduction and green power targets.

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