The Sleeping Giant Awakens

Bio-Energy In the UK

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Stewart is a geographer who undertook post-graduate management training. He ran a local Friends of the Earth (FOE) group and was national energy campaigner for FOE in 1984 during the Chernobyl disaster. He had stints with a sustainable energy trade association and Greenpeace International, before running an international energy efficiency charity. For the past 12 years he has been working in the bio-energy sector at all levels. He runs the Consultancy arm of South East Wood Fuels (SEWF) as well as a bespoke green business film company – One Planet Media. He owns and manages 18 acres of woodland in East Sussex. He is married with one daughter, a step-daughter, and a recent grand-daughter. For fun he hangs out in the woods, runs a Men's Group and sings.

"To be truly radical is to make hope possible,
rather than despair convincing"
Raymond Williams

For my Mum, Ruby Walker Boyle
(1926-2013)
You brought me into this life to make a difference
thanks so much for the love and believing in me

For my beautiful wife Marie-Helene, who has supported and encouraged me throughout – thanks for the love and understanding. You are owed more than a few wild nights out on the town!

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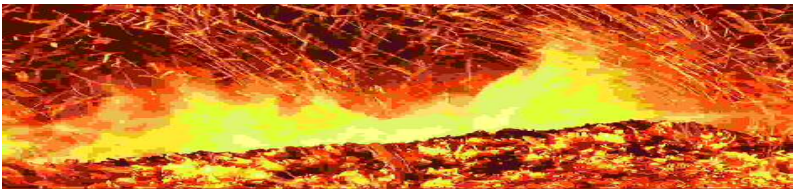

"Bio-energy is one of the most versatile forms of low carbon and renewable energy as it can contribute towards energy generation across the energy spectrum of electricity, heat and transport. In all three sectors, biomass can provide a continuous and constant flow of energy"

UK Bio-Energy Strategy, DECC, 2012

Ch1 - 2030 Vision - the bio-energy future

Heating from woodfuels

It is April 3rd 2030, and more than 360,000 commercial, industrial and public sector building wood heating boilers are now in place in the UK – 40% of the total. These include 2,100 multi-megawatt heating systems in industry, hospitals, distribution centres and hotels. After a slow start, more than 850,000 domestic biomass boilers have been installed – 5% of the UK boiler stock - and are being installed at a current rate of 65,000 a year. Heating oil and LPG boilers are now significantly missing from many off-gas grid areas of rural UK.

To support wood heating systems with quality fuel, the 300th 'Small Woodlands Fuel Hub' was opened by Forestry Minister Greg Michaels in December 2029. The Minister congratulated local foresters and owners who "had cooperated very closely to

get management underway in long neglected local woodlands." The Woodland Trust, a partner in the new initiative, highlighted the "added side-benefits of burgeoning butterfly numbers, bird numbers and wild flowers." The 'Small Woodlands Hubs' complement the 520 fully commercial wood fuel hubs across the country run by a mixture of multi-national and regional fuel companies, and producer groups.

Meanwhile, domestic wood pellet production plants totalling 900,000 tonnes a year were working flat out to support wood heating boilers through an extremely cold winter. Imports from Canada and Scandinavia made up the remaining 75% of commercial and domestic pellet demand. Recycled wood pellets from the UK and imports offered a further 12 million tonnes of capacity for the UK, used in both co-firing power plant and large industrial heating boiler systems.

Power from woodfuels and energy crops

It is June 5th 2030, and, according to the energy regulator OFLOWCARB, biopower in the UK is contributing close to 18% of total electricity supplies. The Government's nominal 400MW biopower 'cap' was removed in 2014 after the 'nuclear deal' with EDF collapsed and the first strong public opposition to shale gas drilling emerged. Construction of a mixture of co-firing, pure

biopower and CHP plant surged from 2014 to 2022, totalling 11,500MW of net capacity. Some of the older co-fired plant began to drop out of circulation from 2025 onwards. Along with 25GW of wind power, two major tidal power projects, and 5GW of solar PV, the combined annual renewable energy contribution has reached over 42% of power supplies.



After a package of measures to support district heating was put in place, including Green Investment Bank support for new heat mains in 8 major UK cities, £2.6 billion worth of projects had moved ahead by 2027. Mike Kingston, the District Heating Czar appointed in 2018, signed off his reign with a "job well done – we don't have to look at Denmark any more for district heating exemplars, we can find them all over the UK."

The increase in the RHI tariff for large biomass plant to 2p/kWh in 2014 galvanised this market. All major off gas grid industrial energy users were incentivised to adopt bio-energy heating and CHP as a condition of a competiveness support package in the tough 2015-16 Budget. The UK slowly climbed out of the deep recession on the back of a major green economic push.

Energy crops such as SRC willow and miscanthus now cover 728,000 hectares (ha) of land. The crops have been largely subsidy-free since 2018 due to high energy prices across Europe.

The third major tree planting initiative by Government's, NGOs and local council's was successfully completed in 2026, with a fourth effort well underway. A total of 500 million trees were planted in less than 10 years under the first two 'Tree for Life' programmes, covering 200,000ha. All new UK citizens have to plant 10 trees as part of the citizenship rules, a sign of the new wood culture built on the 'Grown in Britain' ethos which has become public policy. To coincide with the new tree planting initiative, the 25,000th new job in UK woodlands was highlighted at a ceremony for recently qualified forester Jane Smithfield in Edinburgh. She told reporters: "I'm doing what I love and it's great that I now can have a career with real prospects."

Liquid biofuels from energy crops

The UK met its 10% biofuels target in transport by 2020 and is on target for a 20% target shortly after 2030. 'Second generation' biofuels, including biomethane, cellulosic biodiesel and ethanol, made up 30% of the first target and are on course to provide 60% of the second target.

Super-efficient hybrid cars using blended biofuels and 'green' electricity have become mainstream, with pure Electric Vehicles

(EVs) beginning to dominate urban areas. By 2020 the 250,000th EV car was sold in the UK and ten years later 1.5 million EVs are now registered on the roads. Blended fuel is the fuel of choice for non-urban journeys and E85 (85%) blends are common place on garage forecourts. The standard garage forecourt now offers 'green gas', E15 and E85 blended biofuel-petrol and diesel, as well as super-fast electric charging points and spare battery packs for pure EVs.

'FlexFuel' and hybrid vehicles now make up 65% of all new cars sold. Heavy goods vehicle fuel is dominated by liquid and gaseous biofuels, with a railway renaissance and other demand reduction measures cutting road journeys by a third. Advanced biofuels now make up 30% of airline fuels, heavily based on algae-based feedstock.

In response to the massive impacts of extreme flooding, winds and drought across Europe in 2014, a revised EU Transport Biofuels agreement was reached, with tightening greenhouse gas savings targets. A major bio-ethanol plant in East Anglia was commissioned in 2017, with an output of 600 million litres, and several second generation biofuels plant have been built in Scotland and South West England using woody energy crops.

The Vegetarian Society celebrated the continued fall in meat consumption, down 25% since 2012 and the 10th year of reductions in a row. The move was triggered by meat scandals from 2012 through 2014, and supported by environmental NGOs such as Greenpeace and FOE. Celebrity endorsements, including the Duchess of Cambridge and pop stars like Plan B and Lady Gaga helped the movement away from meat to gain high profile support. The move to less meat has significantly reduced the need for imported soya and UK wheat needed as animal feed.

Biofuels from the waste stream and energy crops

The 1,000th 'carbon- neutral' farm was welcomed in to the 'Farm for the Future' Club in 2030 by Low Energy Farm Minister Sarah Woodham, MP. Utilising Anaerobic Digestion (AD) on the mixed farm in South Leicestershire, the plant utilises animal and food wastes, some external food waste from a nearby Red Leicester organic cheese processor, and green silage. The plant injects excess biomethane into the nearby gas grid and spreads 10,000 tonnes of high quality digestate fertiliser on the land to reduce fertiliser costs and greenhouse emissions to virtually zero.

Linked to solar photovoltaic PV for on-site power generation, and a biomass heating District Heating network linking the farm and a nearby village, the Leicestershire farm exports more energy than it uses, as well as neutralising its methane and nitrous oxide emissions from fertiliser. Energy crops grown on the farm means that it is self-sufficient in wood fuel for the heating system, as well as allowing it to sell wood chips to three other local heating projects. Woodham commented to reporters: "Farming used to

be part of the climate change problem, but I am delighted to see our sector rapidly becoming a key part of the solution and offering low-carbon heat, power and liquid biofuels to the whole UK economy." According to Woodham, "the sector is currently close to carbon neutral for the environment and aims to become a negative source of emissions by 2032."

The 'Carbon-neutral village' movement has recently been celebrating its 500th member and has been working closely with the 'Farm for the Future' programme.

The 'bio-economy' takes over from the oil economy

5th October 2030: The tenth UK bio-economy refinery was opened on Humberside by Prime Minister Caroline Johnson. Using a mixture of algae fuels, cellulosic biomass and animal feed quality wheat, the plant will provide a host of chemicals and raw materials for the bio-plastics, car body, and fuel markets.

Johnson told reporters: "I'm proud to open this plant, which continues to show UK leadership in the circular renewable energy economy, rather than the wasteful one-trip economy we used to depend on." She was presented with a mug made from algae bio-plastics and a 5-litre can of bio-ethanol for her E85 Range-Rover. She quipped: "Well, at least I've got some spare juice if we run out of fuel on the way home!" The comment was

a reference to a threatened strike by oil tanker drivers as oil prices hit $218 barrel and fuel demand fell for the 12th successive year. Oil tanker driver numbers have fallen by 25% in the past 15 years, only partially compensated by increased biofuel deliveries.

PM Johnson, riding high in the polls, talked candidly with journalists after the event. “Back in the dark days of 2013 and 2014, only a few of us saw the potential to re-cast our economy and use our natural resources of wind, waves and bio-energy.” She reminded those present: “Many of our colleagues poured scorn on concerns about climate change and the introduction of early renewable technologies, suggesting they were too expensive and didn’t work. We thought differently and worked with green business to make sure big investments were made into the green economy. I think those investments have paid off big time. With 850,000 jobs directly and indirectly generated by Clean-Tech, green energy and Circular Economy production, fuels and know-how, this has been our biggest industrial success in 100 years.”

2030 Vision – fact or fantasy?

Let us be clear about the underlying basis of this book. Having an energy vision is important. But we also believe that without the hard work and practical reality of projects and people, visions can become mere fantasy. Everything that was mentioned in this brief dip into the future above is already underway, at some level. In some instances, it is commercial or close to. The 30 Case Studies in the book demonstrate the reality of bio-energy at work and doing well. The bio-energy future we describe in this

book does not therefore require massive leaps in imagination or fundamental advances in technology. Big breakthroughs and advances in technology and cost reductions are certainly required, but we are not dealing with technologies like nuclear fusion, where a multi-billion pound 20-year effort is needed to demonstrate that it is even a viable process, never mind turn it into a commercial reality.

So if the bio-energy future is already happening and in many cases working well, what is it and what are the implications of such an energy future?

Bio-energy - what's in a name?

Bio-energy is a word that seems to come straight from the laboratory. In the energy world, bio-energy covers a bewildering array of materials, processes and technologies including wood chip, ethanol, biodiesel, log boilers, pyrolysis, methanol, underfed hearth boilers, wood pellets, bio-char, torrefaction, gasifiers, peat, miscanthus, short rotation coppice (SRC), algal reactors, anaerobic digesters, manure, corn, municipal solid waste (MSW), organic rankine cycle (ORC) engines and bagasse. The list is extensive and growing.

Ask a random group of UK adults in the street what they know about biomass or bio-energy however and the majority will look back blankly. Some might think it connected to biotechnology or GM food. Occasionally, a few might tentatively suggest wood.

Ask the same group of people about wind power or solar energy

and the answers are likely to be a lot more forthcoming and accurate. Some will have their own solar PV panel or know a neighbour who has one, paid for by the Government's Feed in Tariff (FIT) scheme. And yet when you tell the same people that up to 65% of the UK's obligatory 15% renewable target by 2020 is planned to come from a range of bio-energy technologies, and only 2% from solar PV panels on roofs, confusion reigns. PR does not always equal reality. The genesis of the book grew out of this confusion, and the strong feeling that a poor understanding of a crucially important renewable energy source was preventing its wider use.

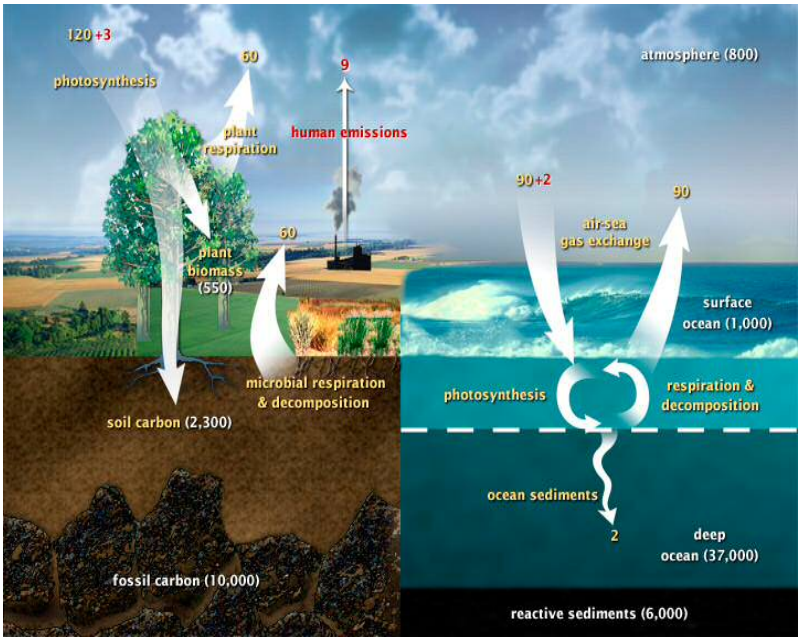

Figure 1 - Carbon Flows and Cycles

Strictly speaking, **biomass** means the mass of living biological organisms in a given area, often expressed as the average or

total mass per hectare of land. A hectare is about the size of 2.5 football pitches. Biomass is measured as the mass of organically bound carbon (C) that is present. Apart from bacteria, the total alive plant biomass on earth is about 550 billion tonnes carbon (gTC) (see Figure 1), with a total annual primary production of biomass on land of around 65 billion tonnes C/year. By contrast, fossil fuel emissions are currently just over 9 billion tonnes a year, and carbon emissions from land-use change just over 1 billion tonnes a year. As we are focusing mainly on the energy aspects of biomass, we use the broad term **bio-energy**. The other term you will see commonly throughout the book is **biofuels.** This is used to describe either liquid or gaseous fuels for the transport sector.

This book demonstrates that the practical potential for all the varied bio-energy options, both in the UK and globally, is large and appropriate and exciting. Alongside a truly serious programme focussed on using energy more efficiently, and a range of other renewable energy technologies, it offers a serious potential to get off the fossil fuel drug that is increasingly killing us and the health of our planet.

Used appropriately and efficiently, bio-energy can shift us away from a carbon emissions curve that seems to grow inexorably into the 'red for danger' zone. With sustained energy policy decisions, good technology choices, and the integration of land-use, energy and transport strategies, the **'food vs fuel'** dichotomy often posed by anti-biofuel campaigners and the food industry need not be the case. We believe that **'food *AND* fuel'** is

the real choice for UK farming and energy policy. There is no reason why farming – currently contributing 8.5% of UK greenhouse gas (GHG) emissions – should not be a net carbon sink for the UK.

We believe that an achievable UK target could deliver well over 10% of our energy needs from bio-energy within 25-30 years, and double that if the UKs projected energy consumption is reduced and energy crop usage is expanded more significantly. This would provide vital low-carbon heat, power and transport fuels.

Getting 10% to 20% of our energy needs from bio-energy is significant and worthy of sustained political support.

Is bio-energy sustainable?

Reaching the 10-20% potential of bio-energy in the UK will require a major effort and journey to re-focus our energy systems. It will also require a grown-up debate based on the science of bio-energy and carbon emissions, and the pragmatic and sustained use of coherent energy policies. As Figure 2 shows, there are significant differences between the bio-energy carbon flow which works within a 'circular economy' and the 'one-stop' cycle of fossil fuels. Understanding that is key to public and political acceptance of using a lot more plants and trees as part of our energy system. The purpose of this book is to explore what that bio-energy journey and those policies might look like, and to provide some route maps.

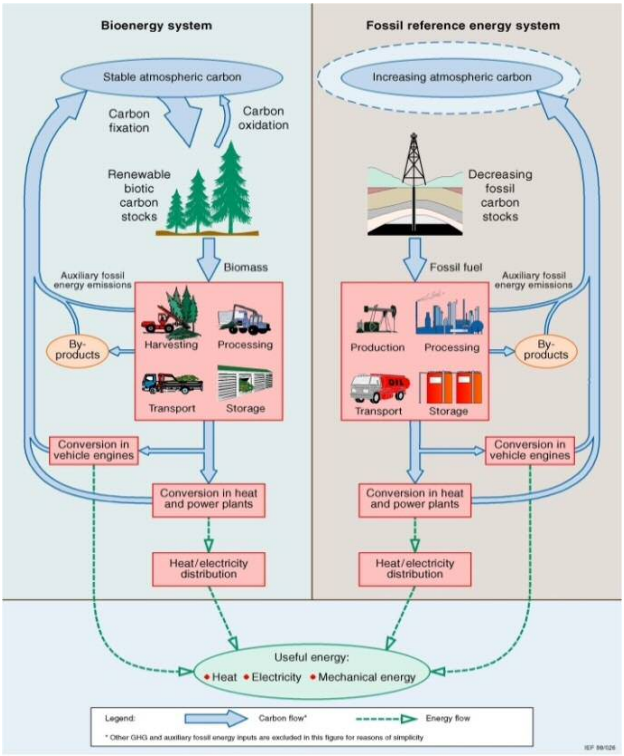

Figure 2: The bio-energy and fossil fuels carbon cycles

Back to the future?

Bio-energy in the form of wood was arguably humankind's first useful renewable energy. In the form of stored solar energy through plants and trees, at some point in the distant past humans discovered that biomass could burn. This combustion created light, heat, the ability to cook and preserve food, and to produce other materials such as charcoal[1]. Charcoal in turn

[1] Evidence suggests that 'Peking Man' was using fire around 500,000 BC. Other evidence shows the controlled use of fire by Hominids took place nearly 1.4million years ago. The use of advanced fire making techniques did not appear to happen until

allowed higher burning temperatures and in time, the working of metals. Today it currently provides the biggest contribution of all the renewable energy options to the energy mix, at around 10% of global energy demand.

The **versatility of bio-energy** is one of its key attributes. Unlike many renewable energy sources such as solar water heating, wind power, solar PV and tidal power, bio-energy can offer useful energy across the range of needs that we in a modern society need. To run an industrialised economy we require **power, heat** and **transport fuels**, as well as **bio-chemicals** to produce a range of products (see Figure 3). Bio-energy can and already does provide all of these.

Today we now live in a 'Peak Oil' world looking at static or diminishing oil production output, and with increasingly desperate attempts to squeeze oil and gas from 'extreme' routes such as Shale Gas and Oil Tar Sands. The versatility of bio-energy makes it as potentially useful as oil has become in the past 160 years, but without the major climatic drawbacks. Unlike the blip that oil will prove to be, bio-energy is a renewable resource offering long-term sustainable options for our evolving society.

Another attribute that makes bio-energy useful is that it provides energy 24/7, 365 days of the year. It is 'despatchable' power, heat and motion which doesn't suffer from the issue of **intermittency** of the sun, wind and waves.

7000BC with Neolithic Man. The Bronze Age lasted from 2500BC to 800BC when metal was first worked using fire.

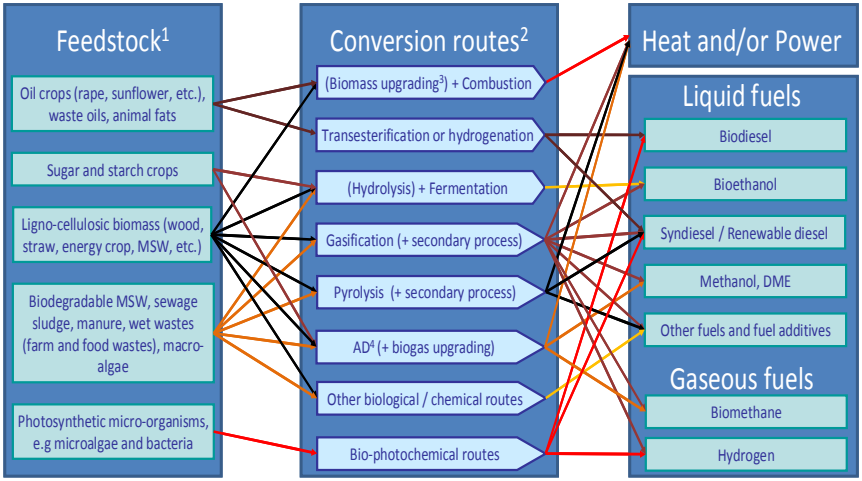

Figure 3. Integrated view of the wide variety of bio-energy feedstock, conversion and end route fuels[2].

Intermittency isn't really the deal-breaker that opponents of renewable energy like to make out. They sometimes announce in grave tones that: "the wind doesn't always blow, you know" as though this issue alone should kill off wind turbines as a serious prospect. This is patently not true, as intermittent energy sources can be stored in many ways ranging from heavy-duty batteries to hot water in tanks, or by using an electricity grid and weather forecasting tools smartly. We already get close to 10% of our power from intermittent sources and we have needed no new storage yet. Tidal power comes in big slugs of power which is as predictable – as the tides. To a certain extent, intermittent

[2] Personal communication, Ausilio Bauen, E4tech

renewables are also complementary to demand, wind output being at its peak in winter evening periods for example. As intermittent sources grow in capacity, however, and storage and management is needed, this will certainly have a cost. This fact does give bio-energy an advantage in being able to provide base-load for heat, power and transport needs.

Energy security and bio-energy

A backdrop to any discussion on future energy supplies is that energy security has become a strategic issue of increasing importance for many countries. The UK Government has growing concerns over 'energy security' as we have increasingly moved back into importing large amounts of energy. From a position of near energy independence in the early 1980s through to 2004, we now import nearly 30% of our energy. We are a net importer of coal, oil and natural gas, as well as 100% of the fuel for nuclear reactors. Domestic gas production is 60% less than in the year 2000 – a huge and worrying fall. A third of our imported gas now arrives in Liquefied Natural Gas (LNG) bulk carriers from countries such as Qatar; a more expensive way of buying gas than via pipelines, but a trend set to continue.

It is within this context that the use of domestic and imported biofuels needs to be considered. Given that we are not a particularly wooded country, how much domestic biofuels can we utilise both today and in future to reduce our dependency on imported gas and oil for the heating and transport sectors? What level of imported biofuels is acceptable given we also import many other products? Biomass can make an important

contribution to global trade, provided good practice is used. Stored solar energy in the form of biomass fuels, exported from Latin America and Africa for cash, or traded with products and services to colder climates in the North, seems a fair exchange.

The US, sometimes aided and abetted by the UK, has gone to war in the Middle East (and North Africa) several times to ensure access to oil. So 'energy security' is not simply an academic concern, it has become one of a growing list of high priority concerns for UK national security. We believe that bio-energy is part of the solution.

Is there enough bio-energy for everyone?

It's important to get some perspective on bio-energy energy. There is enough energy in an hour of sunlight to power mankind's needs for the whole year. Bio-energy is stored solar energy. A big advantage of bio-energy is that, if used efficiently and appropriately, there is plenty of it. Globally, even conservative assessments of the practical potential suggest that 50% of our primary energy needs could be met with bio-energy resources over the next 50-60 years. Regionally within Europe the figure is at least 25%, and could easily be more than 40%.

In the UK itself, we argue conservatively that at least 10% of our energy needs could sustainably come from a variety of bio-energy fuels, sources and technologies within 20-30 years. Assuming really successful energy efficiency programmes that actually cut energy demand, plus the greater use of energy crops, then the bio-energy contribution could increase to more than

20% of the UKs energy supply by 2030-2040[3]. To put that contribution in perspective, nuclear power provides less than 7% of the UKs overall energy demand, despite 50 years of sustained support and massive levels of subsidy.

10% to 20% of our energy supply in a future low-carbon sustainable economy is a bio-energy prize worth attaining.

Bio-energy can make extremely significant contributions to our transport, heating and power needs. They can also offer bio-chemical alternatives to oil-based products such as plastics. The ubiquitous Coca Cola bottle is increasingly moving to a bio-plastic feedstock in Europe, not one based on oil. It's a symbolic shift and an indication of the beginning of the end of the oil age. With oil prices stuck at well over $100/barrel and the International Monetary Fund (IMF) suggesting these could double within 15 years[4], bio-chemicals and even algal energy are today rapidly becoming viable options.

So what's the catch? If it's so versatile, offers 24/7 heat, power and transport, and there is a lot of it, why aren't we all familiar with bio-energy and using it every day? We believe there are several reasons for that.

[3] The UK long-term 2050 carbon reduction target is now subject to annual assessments of the carbon budget – see reports www.decc.gov.uk/en/content/cms/emissions/carbon_budgets/carbon_budgets.aspx

[4] See www.forbes.com/sites/greatspeculations/2012/05/25/big-upside-for-big-oil-stocks-as-imf-study-says-oil-prices-can-double-in-a-decade/

- **Bio-energy has no image -** unlike wind, solar or wave technologies, anyone new to bio-energy usually has no idea what is being discussed and needs a short introduction to understand the subject matter. Bio-energy has the problem of either no image at all or a confused and slightly negative image. Perception lags reality in understanding what this renewable resource is all about. Without understanding, political and public support will be hard to garner.
- **It seems to be old-fashioned –** if bio-energy has an image in the form of wood-based material it is often regarded as old-fashioned; a source of fuel that we used in the past before we moved on to better things. Images of open wood fires, raking ash out and lots of chopping by axes come to mind. Surely this isn't a serious modern energy source?
- **Cutting Trees is Bad – Isn't it? -** The Tree Council proudly states in its literature that it has 'No Axe to Grind. Just Trees to Plant', subliminally implying that cutting trees is bad. Conditioned by images of rainforest destruction, anyone cutting or managing trees is viewed with suspicion by many. Yet without sustainable management UK woodlands would be poor places for biodiversity and cease to provide a viable income for many people. Perceptions are hence again lagging way behind the reality of the exciting range of sustainable fuels and technologies available.
- **It is lower density energy than fossil fuels -** bio-energy is a less dense source than competing fossil fuels such as oil, gas and petrol. To be useful it requires densification and pretty smart technology for it to work. It will need to be used efficiently in future to maximise its impact. Some of this is

fully commercial but some isn't, so there is sometimes an aura of 'laboratory R&D land' sitting around bio-energy sources. Some of the existing so-called 'First Generation' fuels and technologies will provide a transition to better 'Second Generation' technologies. A wide range of great technologies already exist however, many of them commercial or close to.

- **It is sometimes in competition with other biomass end-uses -** there is competition for the materials that make up bio-energy. Chip-board manufacturers and the wood furniture sectors are not especially keen about wood being used in power plants (except their own power plant). They, along with some environmental NGOs, exaggerate and criticise the use of 'whole trees' in power plant to push public opinion against bio-energy. They argue that it competes for some of their raw material, puts up the price and potentially hurts jobs. That's highly debateable, as bio-energy usually doesn't compete for higher quality feedstock. The thorny issue of 'food vs energy' also rears its head when transport fuels are being discussed. With up to 40% of an expanded US Corn crop being used as ethanol in vehicles, this is an issue that certainly needs assessment and calm reflection. It takes a lot of corn and sugar to make ethanol. Processing them with coal as a fuel and then putting them in inefficient 25mpg cars doesn't seem to make a great deal of sense. Thankfully there are much more efficient ways of producing ethanol and biodiesel.
- **Bio-energy sometimes has a confusing message -** the bio-energy business sector itself is not homogenous. Unlike the

solar PV or wind industries, which can articulate and lobby well with clear and simple messages and images, the bio-energy industry doesn't speak with a single voice or have a particularly clear message. It's at times a confusing array of companies from Big Science, Big Chemical, Big Oil and Big Food, mixed with millions of small woodland owners, farmers, local food producers, and DIY biodiesel and pellet manufacturers, plus a bewildering range of bio-energy scientists who have a lot to say. Some parts of the bio-energy sector are also suspicious of other sectors. The heating sector tends to view biopower suspiciously.. All pretty confusing for both politicians and the public – who tend to like things clear and simple. The sector does need to get its act together on how it communicates its message.

Can the sleeping bio-energy giant finally awaken?

"it is not the availability of the resource, but the public policies that will either expand or constrain renewable energy development over the coming decades"

Ramon Pichs, Co-Chair of IPCC Working Group III[5]

Since renewable energy really came of age after the oil price crises in 1973 and 1979, there have been a few false UK bio-energy dawns. Back in the 1980s, the Government had a plan for the massive planting of energy crops and a series of efficient gasification plants. It fell virtually at the first hurdle. The first

[5] Press Release by Intergovernmental Panel on Climate Change (IPCC) Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN), 9 May 2011

40MW(e) gasification plant located near Eggborough in Yorkshire failed to operate properly and approaching £30 million in UK and EU grant monies was wasted. The gasifier ended up in India and the energy crop growers lined up to support this were suddenly left high and dry with no market for their crop.

Less grandiose schemes have been the order of the day since then. With the exception of some successful straw, chicken manure or industrial wood chip power plants, the dominant use of bio-energy recently has been through landfill gas and the co-firing of wood and coal. Most of the fuel for co-firing has been from cheaper bio-energy fuel imports. A modest number of pure biopower plants have also been constructed or given planning permission. A few pure bio-energy CHP plants have been developed, including the twin plants installed by pellet manufacturer Balcas. Several smaller-scale CHP projects are also going live in Scotland, the North of England, Lincolnshire and Humberside, and more are going through commercial assessment in England.

With the introduction of the Renewable Heat Incentive (RHI) in late 2011, and greater support for Anaerobic Digestion (AD), the opportunity for bio-energy to take centre-stage in the UK heating market through solid heating fuels such as wood chip, pellets plus food and animal wastes is now here.

Heating has often been the Cinderella who is never invited to the Energy Ball. Compared to the Electricity and Liquid Transport Fuels brides, who have received massive levels of Government

policy attention and financial support, heating is thought of by many policymakers as rather dull and a low priority. That attitude is changing, as the realisation that close to half of our carbon emissions come from heating, and the sector now has the opportunity to show what it can do. Solid wood heating is now working well in virtually every sector of the economy.

More efficient advanced power combustion technologies such as gasification and pyrolysis can also take their opportunity, with support mechanisms offering more attractive rates of return. Energy from Waste (EfW) plants had a bad image in the past but modern technology is vastly improved on that available 20 years ago. Even with high recycling rates, some Municipal Solid Waste (MSW) will remain and combustion of the organic part makes sense as we move towards a 'circular economy'.

More advanced gasification systems at a smaller scale have been on the edge of commercialisation for some time. While the technical jury remains out on this type of plant in view of previous disappointments, recent signs are promising. Technologies that utilise 'waste' materials in Anaerobic Digestion (AD) systems are also emerging into full commercial viability. This can also be an important option for feeding gas into the grid.

In short, looking across the range of technologies and energy end-uses, we believe that the 'Sleeping Giant' of bio-energy is finally awakening and stepping forward to take its rightful place in the energy mix. We believe that it has a crucial role in our on-going transition to a low-carbon economy. Linked to Carbon

Capture and Storage (CCS), **bio-energy is the only option that allows negative carbon emissions.**

We also believe that there are ample sources of bio-energy fuels which can be utilised sustainably to support a substantial part of the UK, European and global energy economy. Linked with the cluster of important power producing renewables such as wind, tidal, solar and wave power, plus serious energy efficiency programmes, these can cut UK CO_2 and other greenhouse gas emissions dramatically. Without the strong presence of bio-energy however, we believe the UK will seriously struggle to meet tough carbon and renewable energy targets – a conclusion admitted by the UK Government in its 2012 'UK Bio-energy Strategy'. It may be comforting for some environmental non-governmental organisations (NGOs) and 'single-technology' trade associations to think that you can run the UK economy on wind turbines, solar PV panels, heat pumps and electric cars, but you can't. Bio-energy is a critical part of the integrated solution in reaching a low-carbon future.

So welcome to the world of bio-energy. Come with us on a journey to explore the myriad range of technologies and possibilities it can offer to our society. Meet the people who have pioneered great projects and who have important things to say about bio-energy.

Ours is not a rosy-tinted view. Bio-energy is not without its problems and dilemmas – the 'Food vs Fuel' debate needs careful analysis and choices - but bio-energy is also big on solutions to many of our energy problems. A great deal has

already been achieved without much media fanfare or public awareness, and the potential is enormous.

Bio-energy can already be found in action right across our society, offering cost-effective heat, power and motion. It isn't just a set of blue-sky technologies waiting to be proven in the laboratory – though there is also an exciting range of these being developed. **Bio-energy is here and now, and this book highlights some of the action going on.**

With sustained support and a clear and coordinated policy direction – currently lacking in the UK - bio-energy can truly allow us to transition away from a wasteful carbon polluting society to one that works in harmony with nature. It ranks, in our view, as the most important renewable energy source globally, in Europe and in the UK. While Bio-energy is currently the Sleeping Giant of the renewable energy world, it is awakening fast.