HOW REDUCING YOUR CO_2 EMISSIONS COULD INCREASE YOUR BOTTOM LINE

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'Insanity: doing the same thing over and over again and expecting different results.'

Albert Einstein

Introduction

Understandably the primary focus of most business people is on the survival, growth and profitability of their business. Of all the many issues that may keep company bosses awake at night, reducing their carbon emissions is likely to be low on the list of priorities. Some may still even now question the veracity of global warming concerns. Certainly it is not likely to be seen as a boardroom priority or area for active investment with a view to achieving significant Return on Investment (ROI) and positive impact on the bottom line.

Concern with energy consumption and being able to play a part in reducing emissions to take into account world-wide climate change problems is likely to be seen as an altruistic if unrealistic goal, particularly for smaller businesses, and from a hard-nosed business perspective more 'nice to have', than 'must do'.

In this book, I am aiming to present the facts and overturn the view that reducing emissions is not a boardroom issue. More than that, I am aiming to convince you that far from being nice to have, it is a must do because using new technologies, adopting new processes and strategies can significantly benefit your business as much as they do the planet.

I will be reviewing the background to global warming and the international protocols for change and at the various technologies and solutions available to help reduce energy use and emissions, change power resourcing and make money.

By taking active ownership of their energy use, emissions and by using new technologies to make practical changes, including to operating practices, power consumption and more, virtually all business can make a significant and positive impact on their bottom line, and reduce their business's impact on the environment.

In our business, Syntegra Group, we specialise in helping companies to understand their options, and we plan and deliver solutions. In the last section of the book, I will share some case histories to show how a pragmatic, practical approach to reducing emissions can have genuine and lasting business benefits.

In simple terms, the message is: Green business makes sound business sense regardless of the business type or scale there has never been a better time with the UK, European and international governmental focus on carbon reduction, availability of financial incentives allied to increasing legislation and rapidly escalating energy costs to act.

Alan Wing-King

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1 - The World Wakes Up

In this section I want to paint a picture of where we have come from over the last 30 years; how National Governments have come to accept climate change, the international protocols for carbon reduction and how legislation will increasingly affect UK businesses.

"It is incumbent on every generation to pay its own debts as it goes. A principle which if acted upon would save one-half of the wars of the world."

Thomas Jefferson

1.1 A Global Issue

We live in an increasingly globalised society and many issues and many challenges that in the past may have been seen as the concern of national governments or even local communities now clearly affect us all as humankind.

Over the last 30 years there has been a growing acceptance that climate change is real with most scientists agreeing we cannot stop it, but how we respond now will significantly affect the level and speed of change and the future environment for our children and grandchildren.

1.2 A Human Milestone

On the 9th May 2013, carbon levels reached 399.89 parts per million (ppm) at the Mauna Loa observatory in Hawaii, close the milestone 400 ppm figure. In the past 800,000 years, there had never been a time when levels exceeded 300 ppm, pre-Industrial revolution they were only at 280 ppm.

To tackle climate change it is clear that we are no longer able to take a purely selfish nationalistic view without considering the differing levels of economic development and aspirations of developing economies. This makes the solutions and negotiations complex and arguably progress at a global level is painfully slow so it falls to nations and their citizens and businesses to make a difference.

1.3 Greenhouse Gases Create Awareness

Before climate change was recognised widely as a danger to the future of the well-being of humankind, the concern was all about CFCs (Chlorofluorocarbons) and the holes in the ozone layer. Many observers consider the ozone layer issue to be the first sign of a growing understanding that man's actions since the Industrial Revolution were proving detrimental to our planet, and change is needed.

International agreement that something needed to be done swiftly was reached at the Montreal Protocol in 1987 when it was accepted that CFCs were dangerously depleting the Earth's ozone layer.

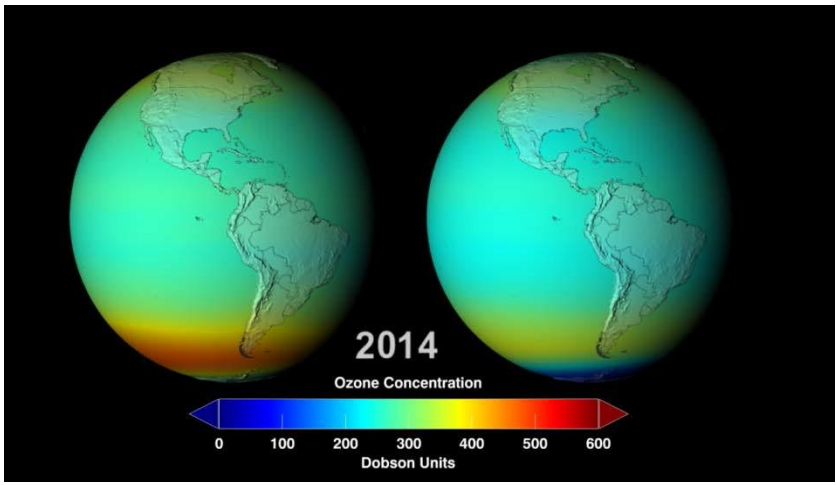
The 'hole in the ozone layer' was big news worldwide, arguably for the first time creating wider public awareness and concern about the effect of our modern lifestyle and industry on the well-being of the Earth.

1.4 First Global Agreement

Montreal led to the phasing out of CFCs used in refrigeration and spray cans in 1987 and further global conferences in 1990, 1991, 1992, 1993, 1995, 1997 and 1999 and an agreement on the phasing out of HCFCs (Hydrochlorofluorocarbons) being replaced with the use of HFCs (Hydrofluorocarbons).
If the international protocols are adhered to, it is expected that the ozone layer will have fully repaired itself by 2050. However, HFCs are now seen by some as a 'super greenhouse gas' with high levels of global warming potential so the cure could be as bad as the problem.

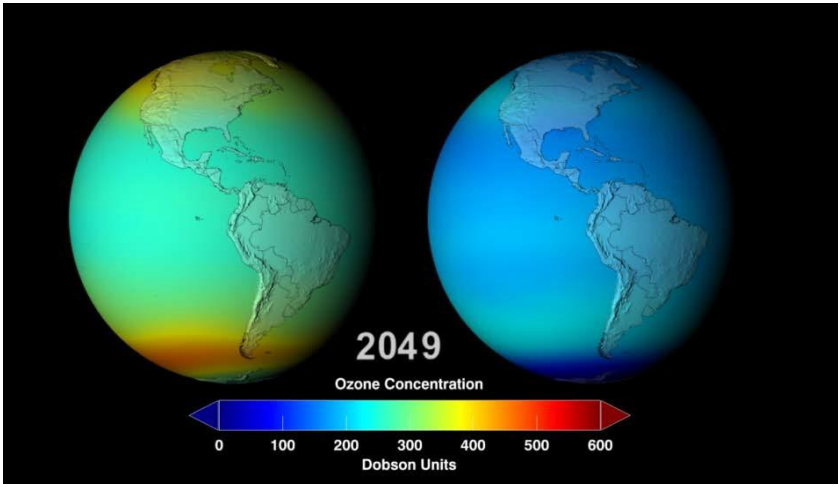
Agreement is yet to be reached between the developed and developing world to monitor, or phase-out, the use of HFCs under the Montreal Protocol.

Figure 1: Montreal Protocol 2014



Source: NASA, 2014.

Figure 2: Montreal Protocol 2049



Source: NASA, 2014.

On the left, in Figure 1 and Figure 2, is a simulation of global concentrations of stratospheric ozone with the Montreal Protocol in place, and on the right is a simulation of global concentrations of stratospheric ozone without the Montreal Protocol in place. This model takes into account atmospheric chemical effects, wind changes and solar radiation changes.

1.5 Kyoto Protocol 1997

The Kyoto Conference in 1997 marked a sea-change in attitudes to climate change resulting in the Kyoto Protocol - an international agreement linked to the United Nations Framework Convention on Climate Change United Nations Framework Convention on Climate Change (UNFCCC).

Adopted by the Parties at Kyoto in December 1997, The Protocol commits its Parties by setting internationally binding greenhouse gas emission reduction targets on industrialised countries. It came into force in 2005. However, the US did not ratify the treaty, and Canada withdrew in 2011.

1.6 Copenhagen Conference 2009

The Copenhagen Climate Change Conference in 2009 raised climate change policy to the highest political level. Close to 115 world leaders attended the high-level segment, making it one of the largest gatherings of world leaders ever outside UN headquarters in New York.

The conference significantly advanced the negotiations on the infrastructure required for effective global climate change cooperation, including improvements to the Clean Development Mechanism of the Kyoto Protocol. Significant progress was also made in narrowing down options and clarifying choices necessary to be made on key issues later on in the negotiations.

1.7 Worldwide Acceptance that Climate Change is Real

The outcome produced the Copenhagen Accord, expressed clear a political intent to constrain carbon and respond to climate change, in both the short and long term. Key outputs included the long-term goal of limiting the maximum global average temperature increase to no more than $2^{o}C$ above pre-industrial levels, subject to review in 2015.

There was, however, no agreement on how practically to achieve this goal, and Copenhagen also included a reference to consider limiting the temperature increase to below $1.5^{o}C$ – a key demand made by vulnerable developing countries.

1.8 Doha Conference 2012

New research on how countries are performing in the fight against global warming released in December 2012 by the world renowned Tyndall Centre for Climate Change Research at the University of East Anglia to coincide with the Doha International Conference. The Tyndall research revealed that the biggest contributor to global emissions in 2012, and growing at the fastest rate, was China who was emitting 28% of total carbon dioxide (CO_2) – an increase of nearly 10%.

Second to China was the United States accounting for 16% in total emissions, followed by the European Union at 11%. However, emissions from the US fell by 1.8% and EU's CO_2 output fell 2.8% over the period, driven partially by the recession and the switch to natural gas and renewables. In pure growth terms, India was second to China increasing by 7.5% during the last year primarily because of its increased use of coal.

Just looking at the raw data and economic trends it is clear that China, India and other growth economies will continue to grow their emissions, and without significant efforts that go beyond today's global commitments, climate change will be irreversible.

1.9 Inexorable Temperature Rise

In fact, the Tyndall Report warned that if levels of CO_2 levels continue to grow at the current rate, global warming is on a course to increase a rise to 4^{o}C or even 6^{o}C by the end of the century.

The December 2012 Doha Conference resulted in amendments to the Kyoto Protocol including changes to the country targets for greenhouse emissions.

1.10 The European and UK Contribution

The EU is under pressure to agree to cut carbon emissions under a second-commitment period of the Kyoto Protocol from 2013 onwards, and that will include the UK. Under the Kyoto/Burden Sharing Agreement, the UK's contribution is to cut greenhouse gas emissions by 12.5% by 2008 – 12 versus 1990 base year.

1.11 UK Climate Change Act Raises the Bar

The Climate Change Act 2008 went beyond Kyoto, setting legally binding target of 80% reduction in greenhouse gas emissions by 2050. The Climate Change Act also established the independent Climate Change Committee to advise on setting 5-year Carbon Budgets. An interim target of 34% reduction from 1990-2020 was set, and this will increase to 42% if a significant international agreement is secured.

Latest data on 2012, UK emissions of the six greenhouse gases covered by Kyoto Protocol were provisionally estimated to be 571.6 million tonnes (Mt) CO_2 equivalent. This was 3.5% higher than the 2011 figure of 552.6 Mt.

CO_2 is the main UK greenhouse gas emission, accounting for about 83% of the total of the country's greenhouse gases in 2011, the latest period for which final results are available.

The UK's $C0_2$ footprint showed an increase of 10% between 2009–2010. This followed a 19% fall in 2009 and left the $C0_2$ footprint 9% higher than it was in 1993. In 2012, UK net emissions of CO_2 were provisionally estimated to be 479.1 Mt. This was 4.5% higher than the 2011 figure of 458.6 Mt.

1.12 Changing UK Legislation

The 2008 Climate Change Act targeted a reduction in greenhouse gas emissions of 34% by 2020 and a massive 80% by 2050. The fact is that the timeline and targets for zero carbon building are ever changing. In March 2013, the UK Government's Budget made a commitment to publish a detailed plan setting out Government's response to the 2012 building regulations consultation on energy efficiency requirements. In addition, and by the Summer Recess 2013, the Government committed to consulting on the next steps for the zero carbon homes policy, including the means for delivering allowable solution.

One thing is clear the UK Government is set on a course that will mean that Britain leads by example and becomes one the world's lowest carbon economies, supporting carbon reduction targets with tough legislation including Mandatory Carbon Reporting (MCR) governing Publicly Listed Companies.

1.13 Encouraging Investment

In Spring 2013, the UK government published an update regarding its "Final Investment Decision Enabling programme," which has been designed to help developers of low-carbon electricity projects to make final investment decisions before the electricity market changes in the second half of 2014. Through this programme, developers of renewable electricity projects will be in the position of applying for support, to enable them to commission and build new projects more quickly.

The aim of the government is to offer investment contracts to successful applicants in Autumn 2013 based on the draft strike prices and contract terms that are going to be published in the Summer. The aim is to incentivise developers to make final investment decisions this year, followed by a process will allow the beginning of construction of a number of projects quickly.

1.14 Targeting UK Domicile Private Limited Companies (PLCs)

In April 2013 MCR became a prerequisite for all Companies listed on the London Stock Exchange. The UK already leads Europe in carbon emission reduction, but now listed companies must report to Shareholders, not just on their financial health in their annual report but also their level of greenhouse gas emissions.

Within the framework of global agreements, multi-nationals with offices in different geographies will have their own set of challenges. Their criteria for achieving carbon savings and reducing costs may be governed by country practices, rules and tariffs in which they operate. If they have a strong UK presence, a public company's decision making may be influenced by whether they are considered to be a UK company or foreign-domiciled.

1.15 Too Small to Benefit?

There are approximately 4.8 million small businesses in the UK, for these businesses and companies the temptation is probably to take *'so what'* view after all at the moment MCR is requirement only for publicly listed companies. However, zero carbon targets, changing timelines and requirements for new building standards will ultimately affect businesses large and small.

Ultimately, MCR is likely to have a knock-on effect on businesses of all sizes as what starts at the top is certain to ripple outwards. It is likely that even smaller companies will, in the future, need to demonstrate their commitment to socially responsible emissions behaviour to win business just as they do to sound financial management - especially if they are working with larger organisations with formal carbon management policies and requirements.

Reducing carbon emissions could be seen as the responsibility of every man, woman and child after all everyone is, and will be, affected by change brought about by global warming.

In 2012, an estimated 40% of CO_2 emissions were from the energy supply sector, 24% from transport, 17% from business and 15% from the residential sector.

1.16 Renewables Generation Rises Rapidly

The increases figures for energy generated from renewable sources from July 2011 to July 2012 show the energy supply sector is moving the right direction with:

- An increase of 27% of the electricity generated from renewable energy
- An increase of 40% of the capacity of renewable electricity
- An increase of 60% of offshore wind power
- An increase of five times of the PV capacity

However, we can see whilst changing people's behaviour and reducing personal carbon footprint is important, and continued investment into renewable energy is critical, without a significant commitment from the Business Sector, stopping or even reversing climate change is likely to be an uphill battle.

Useful Contacts

NASA
www.nasa.gov

2 - Why Effective Energy Management is becoming a Core Business Challenge

In this section we will look at how the triple bottom line[1] - people, planet, profit - affects UK Businesses; what the drivers are for change and how to define a practical approach for your business.

"Vision without action is just a dream, action without vision just passes the time, vision with action can change the world."

Nelson Mandela

[1] John Elkington 1997 *Cannibals with Forks: the Triple Bottom Line of 21st Century Business*

2.1 People Power

The so-called triple bottom line (TBL) takes into account all the factors that business impacts and attempts to capture the multiple values, social, economic and ecological. The old wives' adage, a stitch in time saves nine, could well be applied to the whole area of corporate responsibility and the triple bottom line. In other words, it is better to take some decisive action than be caught-out doing nothing. The new UK public limited company (PLC) reporting rules requiring the annual information on both economic and emissions performance typifies the approach to TBL thinking.

In the private sector, commitment to corporate social responsibility now implies a commitment to TBL thinking and reporting, which may manifest itself as board level monitoring; specific programmes for emissions improvement, staffing and other resources and adherence to voluntary standards including the 10 UN Compact-Ceres Principles. These principles include the treatment of labour, respect for human rights, abhorrence of corruption and environmental responsibility.

2.2 Ethical Working Conditions

Since mid-2013, the importance of TBL thinking was highlighted by the Bangladesh clothing factory disaster, where it is clear that global brands are still far from innocent in buying from suppliers whose business practices are a long way from adhering to the UN principles.

In a bid to be seen to have clean hands, major companies like Tommy Hillfiger, PvH and Calvin Kline that rushed to sign up to the Bangladesh Building Fire and Safety Accord[2] that requires the publication of independent fire safety building inspections. The accord now has over 150 companies located in 20 countries as signatories and is a legally binding agreement. Whether consumers vote with their feet or accept higher prices in return for a cleaner conscience remains to be seen.

2.3 A Taxing Issue

The second and thorny issue illustrating the complexity of defining a practical TBL policy is it that of corporation tax payable (or not) by the global players. Companies like Apple, Google and Starbucks are arguably quite correct in their thinking, behaviour and defence that their priority is to their shareholders to maximise profits, and if the system is what is wrong they cannot be blamed. It is not in their efforts to avoid paying and delivering more profit, the requirement is for a global taxation framework that takes account of the changing nature of big business.

Whatever the position one takes it is clear that stakeholder power – customer, ethical investor and Government will be an increasingly important factor in, potentially, not just in the profitability but the long-term sustainability of many businesses. In the social media age, where everyone can be watched by everyone else all the time, if you are found wanting then your business could be at risk.

2 http://www.bangladeshaccord.org/

2.4 The Simple Equation

Every business, regardless of its size and the nature of its business, wants to reduce cost, increase revenues and accrue profit. In an ever more competitive market, energy management is rapidly becoming a mission critical component in building and running a sustainable business. Even small adjustments to working practices can mean the difference between profit and loss.

Notwithstanding current or any future legislation and social responsibility for carbon emissions, the seemingly continuous upward spiral of energy costs highlights a practical business issue, and provides compelling financial reasons to act and find lower cost, better solutions that meet business needs.

It is a simple equation: If energy costs are set to continue to rise inexorably, and there is every indication they are, then either businesses must choose whether to increase prices, lower profit expectations, reduce power usage or find alternative, lower cost energy sources.

That is the stark choice. Do something, and there is every chance of not just creating a better, more competitive business, but one that can last. Do nothing and the results are likely to be a slow and steady erosion of the business.

The good news is that businesses that invest in their own renewable energy generation can hedge against future tariff uncertainty and fulfil part of their TBL responsibility by significantly reducing their carbon footprint at the same time.

Moreover, the solutions that provide renewable energy sources for business often create new and sustainable revenue streams as a bi-product. In fact in almost all cases, reducing, managing or removing energy altogether from the Operational Expenditure (OpEx) costs is likely to be win/win making a positive, sustainable and often surprisingly affordable contribution helping virtually any business, regardless of its scale, to achieve a profitable TBL.

2.5 Interest is Growing

A survey by Business Energy Supplier Opus Energy found a growing interest amongst UK businesses (39% of those surveyed) in generating their own renewable energy by 2015. These advantages are highlighted in the Opus Energy survey[3], where the three main benefits stated by businesses for renewable energy generation were given as:

- Have a self-sufficient supply of energy (28%)
- Generate additional income (23%)
- 'Doing our bit' to tackle climate change (17%)
- CHP – Combined Heat and Power generation

Businesses that aren't currently taking note of energy legislation and prioritising energy management and carbon reduction are missing out on a significant opportunity to accrue cash benefits to their bottom line.

If a business is currently profitable but does not have an Emissions Management Programme, then making changes – even quite small ones – has been proven to save money and potentially create a new revenue stream, for example through reselling excess power to the Grid. In this way, savings and earnings can be a considerable and accrue directly to the bottom line.

[3] Opus Energy News January 2013

2.6 Understanding Your Options

The fact is that many people see emissions reduction as a complex issue and neither core to their business now or part of strategic planning for the future. Few realise the potential to use new technologies and more effective monitoring to cut emissions and to reduce their business costs by as much as 30% at the same time. What changes a company can achieve; what improvements to its carbon footprint are practical and how flexible the business is to change will depend to a large extent on the type of business, scale and current financial position. However, often the payback can be far faster than expected; especially if it starts with some minor low cost - or even free - changes that can still have a significant impact on both emissions output and cash burn.

Clearly, companies operating a manufacturing plant, a logistics operation or business with a large scale workforce face a different set of challenges and opportunities than organisations that are largely office and services based.

Investment into new plant and machinery or building refurbishment may well be the ideal solutions but, at a time when capital is tight, finding support for budgets to make these investments can be challenging.

To support the drive for resources it is important to know what external support including grants, rebates and tariffs are available, as well as what the different options are and to be able to weigh-up the benefits of different technologies and solutions. Additionally, to decide how to plan for your future business energy needs you ideally need the full picture. This includes how Government–backed including Feed-in Tariffs (FITs), grants and incentives will not only earn revenues, by buying back your surplus electricity, but can help stretch resources further including available capital.

2.7 Sound Business Sense

Reducing emissions and costs is not just about employing new technologies, it is about engaging people. According the Carbon Trust, UK companies and public bodies could save as much as £500m and reduce CO_2 emissions by 2m tonnes by encouraging employees to cut energy use, reduce paper waste and use alternative ways of working to cut back on travel. Even smaller businesses can benefit with an average cost reduction of between £6-150K depending on the size of business.

All UK businesses can benefit from making emissions and energy management a core part of their business planning process, and virtually every business can implement a practical energy management policy that can reduce costs and has the potential to add revenue to their bottom line.

As we head towards the mid-point in the second decade in the 21st Century, with global warming now accepted by the mainstream and social responsibility proving a powerful driver for profitable business, sound energy management practices clearly have their place, just as taking account of people and planet do, and all can add-up to a business that is both sustainable and profitable.

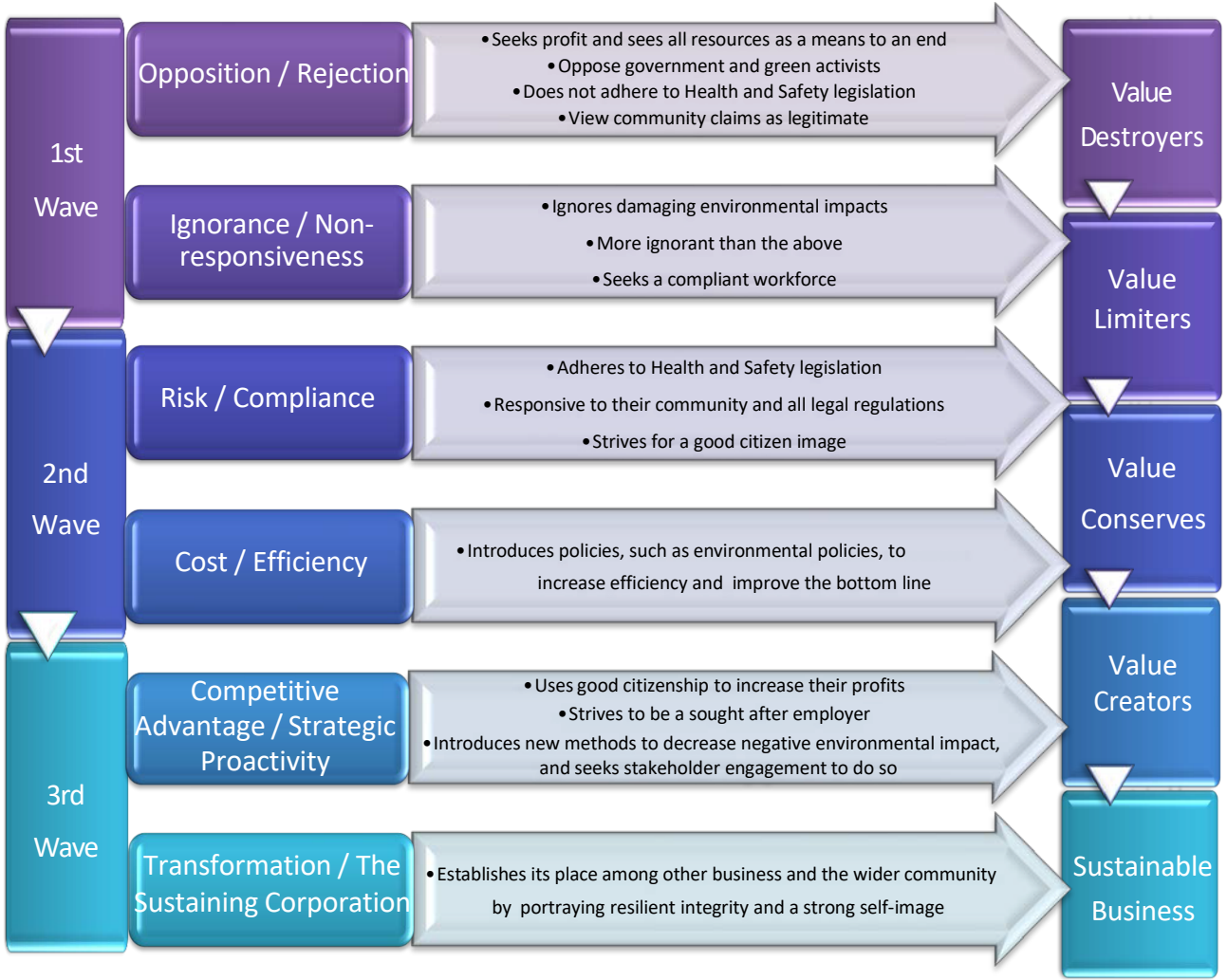


Figure 3: The Sustainability Spectrum

So the message is simple: *Going green makes sound business sense*. Whether it is a concern for customer pressure, meeting Government legislation or plain humanity, it is apparent that the triple bottom line is rapidly moving from a '*nice to have idea'* to a mission critical business requirement.

3 - Towards Zero Carbon Buildings

In this section and we focus on new build – planning, design and certification considerations and low carbon refurbishment options.

"A designer knows he has achieved perfection not when there is nothing left to add, but when there is nothing left to take away."

Antoine de Saint-Exupery
(Writer and pioneering aviator)

3.1 Planning Considerations

Development planning is complex, and in considering any new building development; European, UK National, Regional and Local Planning Policies, allied to changing Building Regulations all need to be considered, and adhered to, at each stage of the process.

The National Planning Policy Framework[4] published in March 2012 is an important part of the government's reforms aiming to make the planning system for England less complex.

The Framework sets out planning policies for England and how they are expected to be applied. It provides guidance for local planning authorities and decision-takers, both in drawing up plans and making decisions about planning applications.

There are three dimensions to sustainable development: economic, social and environmental. These dimensions give rise to the need for the planning system to perform a number of roles:

- An economic role – contributing to building a strong, responsive and competitive economy, by ensuring that sufficient land of the right type is available in the right places and at the right time to support growth and innovation. Also by identifying and coordinating development requirements, including the provision of infrastructure.

[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

- A social role – supporting strong, vibrant and healthy communities providing a supply of housing required to meet the needs of the present and future generations, and by creating a high quality built environment, with accessible local services that reflect the community's needs and support its health, social and cultural well-being.

- An environmental role – contributing to protecting and enhancing our natural, built and historic environment, and as part of this, helping to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate and adapt to climate change including moving to a low-carbon economy.

The framework does not contain specific waste policies since National Waste Planning Policy,[5] was published as part of the National Waste Management Plan for England (December 2013). The London Plan, the overall strategic plan for London, setting out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031 is an example of the regional approach required to translate the Planning Policy Framework into workable local policies. The London Plan forms part of the development plan for Greater London. London Boroughs' local plans need to be in general conformity with the London Plan, and its policies guide decisions on planning applications by councils and the Mayor.

[5] https://www.gov.uk/government/publications/waste-management-plan-for-england

3.2 National Calculation Methodology

The National Calculation Method (NCM)[6] is the Energy Performance Directive for compliance on non-dwelling buildings with Building Regulations as defined by the Department for Communities and Local Government.

NCM methodology directs industry towards a whole building performance analysis in terms of limits on CO_2 emissions. In the previous legislation measurements were made on an elemental basis, which allowed for system responsibility to be devolved among the various construction suppliers. This directive requires an integrated design approach between fabric, structure and systems.

- Building performance standards requires standards to be set for overall energy performance of new and existing buildings and encourages the greater use of low and zero carbon sources.

- Building certification requires energy performance certificates to be provided when buildings are constructed, sold or rented out.

Underpinning NCM is SBEM, a computer programme that provides analysis of building's energy consumption by comparing the projected annual energy use by a proposed building and comparing it with a notional building.

[6] http://www.ncm.bre.co.uk/

3.3 Design and Simulation

Logically the best time to plan for maximising carbon reduction and energy efficiency in an industrial building or offices is at the design stage, but for the designer the challenge is to meet required carbon reduction and energy efficiency standards, fulfil the client's needs and ensure the build remains within the cost parameters.

Building modelling is an effective way to plan and assess the energy performance of a new building design. Until recently, changing parameters during the design process and making new assessments were time consuming and costly.

Now however, new software tools allow designers to run multiple simulations for different scenarios, predicting energy consumption and producing cost data to support design decisions. This means an enormous range of variables can be assessed against desired criteria including minimisation of capital cost, minimising energy use and minimising CO_2 emissions thus improving human comfort and climate temperature range and air quality.

Typical results are now showing carbon reductions of up to 30% by subjecting concept designs to this type of engineering analysis with built-in optimisation variables. These include building orientation, construction type, window area (pro-rata to scale), mechanical and natural ventilation rates, lighting, heating, ventilation and air conditioning (HVAC) and cooling set point solar PV and wind turbine power.

Low energy buildings incorporate a combination of high insulation, passive design features, energy efficient technologies and automatic controls to minimise the requirements associated with these services. The selection of a particular Low Zero Carbon (LZC) technology is usually dependant on a range of factors with varying importance to decision makers. The main factors are:

- Cost effectiveness and financial return: Several initiatives have been developed to encourage the take-up of specific technologies through targeted grant schemes.

- Carbon saving potential (CO_2): LZC sources of energy are usually considered as an option when seeking to reduce the demand for energy, and carbon emissions. There are statutory obligations, which must be met, but some planning authorities or developers may wish to set more challenging targets than the minimum requirements.

- Promotional value: This can range from the immediate impact of visibly sustainable features of buildings demonstrating the corporate social responsibility (CSR) credentials of the owners to improving the saleability of buildings which inherently have a lower energy demand. In either case, LZC sources provide an opportunity to "market" the image of the building owners or occupiers.

3.4 Building Research Establishment Environmental Assessment Method (BREEAM) Certification

BREEAM is the most comprehensive and widely recognised measures of a building's environmental performance. The system uses recognised measures of performance including water and energy use, pollution, waste, ecology and management processes and sets the standard for best practice in sustainable building design, construction and operation.

The BREEAM system encourages designers, clients and others to think about low carbon and low impact design by minimising the energy demands created by a building before considering energy efficiency and low carbon technologies.

BREEAM assessments are based on a scoring system carried out against nine criteria:

- Energy
- Land use and ecology
- Water
- Health and well-being
- Pollution
- Transport
- Materials
- Waste
- Management

BREEAM can be applied to refurbished as well as new build commercial and residential buildings and currently applies to offices, retail premises, public buildings (hospitals, schools and prisons etc.) and multi-residential buildings with communal facilities e.g. Halls of Residence, care homes and sheltered accommodation.

BREEAM In-Use is a scheme to help building managers reduce the running costs and improve the environmental performance of existing buildings. It consists of a standard, easy-to-use assessment methodology and an independent certification process that provides a clear and credible route map to improving sustainability. BREEAM In-Use is designed to:

- Reduce operational costs.
- Enhance the value and marketability of property assets.
- Provide a transparent platform for landlords, owners and tenants to identify and negotiate building improvements.

- Provide a route to compliance with environmental legislation and standards, including energy labelling and ISO 14001.

- Facilitate engagement with staff in the identification of productivity improvements and sustainable business practices.

- Provide a vehicle to evaluate and improve Corporate Social Responsibility (CSR).

- Provide genuine evidence of sustainability and CSR.

Parts 1 and 2 of the BREEAM In-Use Certification Scheme are relevant to all non-domestic i.e. commercial, industrial, retail and institutional buildings. Part 3 of the BREEAM In-Use certification scheme is currently restricted to offices. The biggest opportunity to address the environmental impact lies in better management and improvement of the existing building stock. BREEAM In-Use has been developed to recognise and encourage better building management and targeted investment in existing building stock.

3.5 Leadership in Energy and Environmental Design (LEED)

LEED is a competitive assessment to BREEAM imported from the United States breaking BREEAM's 20 year dominance in the UK building certification and of particular relevance to US headquartered multi-nationals to assess the buildings around the world.

BREEAM tends to be based on UK/European standards and practices and is considered more adaptable to local conditions for example the local scarcity of water or other resources.

There are LEED ratings for:

- New construction
- Existing buildings: operations and maintenance
- Commercial interiors
- Core and shell
- Schools
- Retail
- Healthcare
- Homes
- Neighbourhood development

Where a mixed construction is used a particular system must be adopted if more than 60% of the gross floor area is suitable for that system. If less than 40% is suitable, then that system should not be used, and if it is between 40%-60% it is suitable; then adoption of that system is at the project team's discretion. Projects reassessed against a number of criteria:

- Site sustainability
- Water efficiency
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality
- Locations, transport and access to open space
- Awareness and education
- Innovation in design
- Meeting regional priorities

3.6 SKA Rating

The SKA rating was introduced by Skansen who initiated a research project to investigate whether it was possible to measure either the environmental impact or measure good environmental practice of commercial fit-out projects. The objective was to remove the ambiguity in the commercial fitting out and commercial refurbishment industry. The result of the project was the SKA rating, which has now been adopted by RICS who commissioned the research project along with AECOM.

The SKA Standard is led and owned by the Royal Institute of Chartered Surveyors (RICS). It is an environmental assessment method, benchmark and standard designed specifically for non-domestic fit-outs as against BREEAM and LEED that are aimed at whole building assessments.

The SKA scheme assesses fit-outs against over one hundred best practice measures covering energy and CO_2 emissions, waste, water, materials, pollution, wellbeing and transport.[7] For tenants and other occupiers it offers a benchmark against which the organisation can manage and promote its green credentials including for ISO 14001 accredited organisations helping to support their environmental management system.

For developers and landlords SKA enables them to benchmark the sustainability of their fit-outs across their portfolio of properties. SKA increasingly makes sound business sense as it provides a rating to drive up the sustainability value of properties and helps to protect buildings already certified under other methods.

[7] Benefits of SKA www.rics.org

3.7 Zero Carbon Buildings

Following on from its announcement in 2006 of a Zero Carbon Homes Policy by 2016, the then Labour Government announced in the 2008 Budget its intention that from 2019 every new non-domestic building should be zero carbon. In order to demonstrate government leadership in tackling climate change, an additional ambition for new public sector buildings to be zero carbon from 2018 and all non-domestic building by 2019, three years after the domestic homes sector.

It is currently envisaged that achieving zero carbon non-domestic buildings should adopt a similar hierarchy of measures to those proposed for domestic buildings:

- Building fabric efficiency to reduce the demand for heating, cooling, mechanical ventilation and electric lighting.

- Meeting the demand for services with high efficiency equipment and efficient energy management.

- Supplying equipment with low carbon energy.

- Offsetting remaining emissions by generating further renewable energy.

As with zero carbon homes, unregulated energy (such as appliances) is likely to be excluded from emissions calculations.

The standards to be achieved will be set out in the building regulations and associated approved documents, in particular Part L, the conservation of fuel and power. The overall standards set in the current 2010 Part L are based on achieving a percentage reduction in carbon emissions compared to the carbon emissions of a building of the same type, size and shape built to 2006 standards. Revisions of Part L in 2013 and 2016 will require larger reductions in these carbon emissions compared to the 2006 standards, progressing towards the ultimate goal of 'zero carbon' by 2019.

There are a number of concerns with zero carbon non-domestic buildings, other than the obvious uncertainty that will remain until the final standards are known. There is some concern that the standards will be watered down before 2019, and developers may decide it is easier and adopt 'allowable solutions' rather than meet the carbon compliance standards. It is questionable whether the current standards achieve 'zero carbon.' In particular, as with other standards, such as BREEAM and LEED, they focus on operating emissions rather than capital emissions i.e. not taking account of carbon emissions resulting from constructing a new building.

It is not clear how the long-term maintenance, user behaviour or any future alterations to new buildings will be regulated, or the results measured and questions remain unanswered about measures to deal with the difference between the predicted and actual energy performance of buildings which can be significant.

There is also concern about whether the time-frame for change is realistic, and the relationship will be between planning permission requirements and building regulations requirements.

3.8 CO_2 Building Emissions Certification

Non-domestic buildings tend to be large and can often have a significant impact on the environment, of which energy consumption and associated carbon emissions are considered to be amongst the most important. It is estimated that non-domestic buildings currently account for up to 17% of all UK Carbon emissions.[8]

Currently, two forms of Certification are available and a further roll-out is being considered by the UK Government:

3.81 Display Energy Certificate (DECs)

A Display Energy Certificate (DEC) or operational rating, records the actual CO_2 emissions from a building over the course of a year and benchmarks them against buildings of similar use. It is renewed each year and is accompanied by an Advisory Report that sets-out measures to improve the buildings efficiency.

Since January 2013 all Public Institutions with between 500-1000 m² of floor area e.g. Public Authority buildings, libraries, NHS trusts and public amenities like swimming pools etc. have been required to display a DEC for the next 10 years showing how the building is performing, and what areas can be improved e.g. lighting, heating and cooling management and onsite renewables etc.

[8] Carbon Trust - Building the future today

3.82 Energy Performance Certificates (EPCs)

An Energy Performance Certificate (EPC) or asset rating, models the theoretical, as designed, energy efficiency of a particular building. This is based on the performance potential of the building itself (the fabric) and its services (such as heating, ventilation and lighting), compared to an approved benchmark. So an EPC does not measure the actual building performance but its possible performance.

An EPC assessment will follow one of the following three types of methodology:

Construction
- – new build
- – refurbishment
- – conversion

} Domestic / Commercial

Domestic
- – existing buildings

EPCs are valid for 10 years. They must be made available free of charge to prospective buyers or tenants at the earliest opportunity, and where EPCs are available, adverts must show the energy rating of a building.

They are required when buildings are built, sold or rented if they have a roof and walls and use energy to condition an indoor climate.

If a building contains separate units (for example a block of flats), each unit needs an EPC. Buildings that do not require an energy performance certificate include:

- Stand-alone buildings – floor area less than 50 sq m

- Industrial and agricultural buildings – with low energy requirements

- Protected buildings – where compliance with energy efficiency requirements would unacceptably alter their character or appearance

- Rented dwellings – occupied by the same tenant since before 1 October 2008

- Places of worship

- Temporary buildings

- Buildings suitable for demolition

Buildings are rated from A to G on EPCs, where A represents a very efficient building and G a very inefficient building.

EPCs are provided by accredited energy assessors who will also provide a recommendation report to help owners and occupiers make their building more energy efficient, and may identify recommendations that could be eligible for Green Deal financing.

Currently, there is no requirement to follow the recommendations. However the Energy Act 2011 stipulates that from 2018 it will be illegal to let buildings that do not meet minimum energy performance standards; so this will be a concern for landlords wanting to continue an ROI from existing commercial lets.

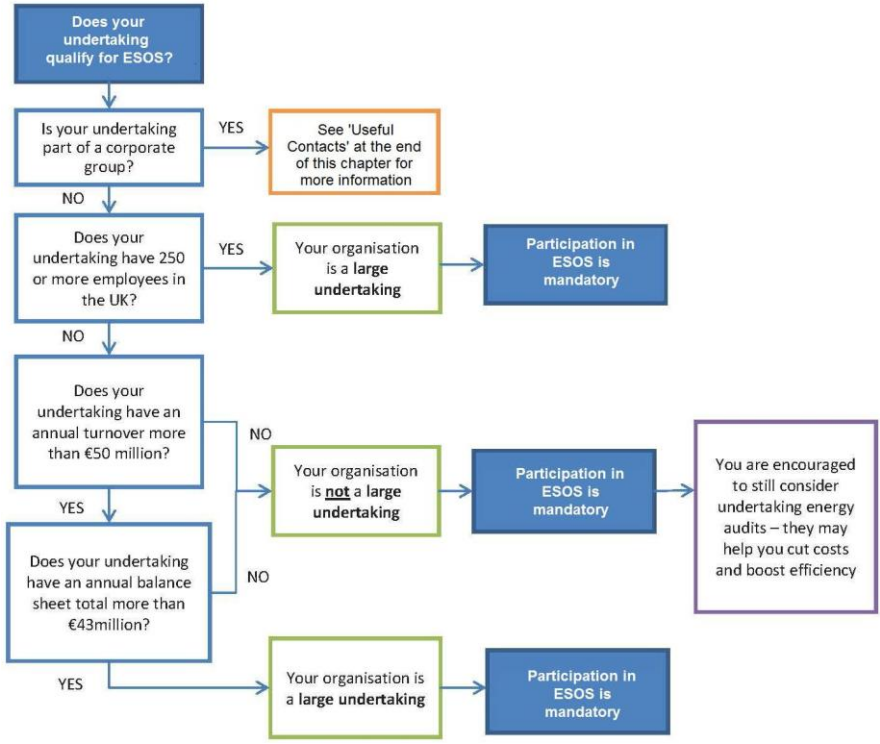
3.9 Energy Saving Opportunity Scheme (ESOS)

The Energy Savings Opportunity Scheme (ESOS) is a mandatory energy assessment and energy saving identification scheme for large undertakings (and their corporate groups). The scheme applies throughout the UK. ESOS is being established by the Department of Energy and Climate Change (DECC) in response to the requirement for all Member States of the European Union to implement Article 8 of the Energy Efficiency Directive.
ESOS scope states three conditions:

1. An undertaking which has 250 or more employees1 in the UK.
2. An undertaking which has fewer than 250 employees, but has:
    - An annual turnover exceeding €50m (around £39m).
    - A balance sheet exceeding €43m (around £34m).
3. Part of a corporate group which includes an undertaking which meets criteria (1) or (2) above.

If, on the qualification date (31 December 2014 for the first phase of ESOS), the company fits within any of the three conditions, mentioned above, ESOS compliance will become mandatory and the company will become a participant. Figure 4 can be used to identify if you are a participant.

Figure 4: Are you a participant?



3.91 ESOS Benefits

ESOS is intended to provide high quality and targeted advice to large enterprises on cost-effective energy efficiency opportunities, which will ultimately lead to financial savings. Participants who invest more time and effort in their ESOS audits are more likely to identify further financial savings as a result of reduced energy consumption.

Optimizing energy use leads to improved profitability and increased competitiveness. It also constitutes an integral part of the UK's climate change mitigation effort, as demonstrated by the CCA (Climate Change Agreement) scheme, the CRC (Carbon Reduction Commitment) Energy Efficiency scheme and the EU Emission Trading System (ETS). There is significant potential to decrease energy consumption across all sectors, and yet opportunities to improve energy efficiency are often under-exploited.

DECC (Department of Energy & Climate Change) estimates that ESOS could realize £1.6bn net present value of benefits to the UK (2015-2030), with the vast majority of these being directly felt by businesses in the form of reduced energy bills. This benefit would be realized if participants in ESOS reduced their energy consumption by an average of 0.7%.

This would also lead to energy savings of around 3TWh per year – that's enough energy to power nearly 160,000 households for a year. However, businesses and the UK as a whole will only realize this benefit (which more than offsets the cost of complying with ESOS) if they implement the cost-effective recommendations identified in ESOS audits and engage with their auditor to ensure that they have access to the information and staff they need to develop meaningful recommendations.

3.92 Deadlines for compliance and notification

Table 1 indicates the deadlines for compliance until 2023. ESOS will operate in four-yearly compliance phases. Organizations in the UK must assess whether or not they are required to participate in ESOS on the qualification date of each phase. The qualification date for the first phase is the 31st December 2014. The last day of each compliance phase ("the compliance date") is the date by which the participant must have undertaken its ESOS Assessment and notified its compliance to the Environment Agency.

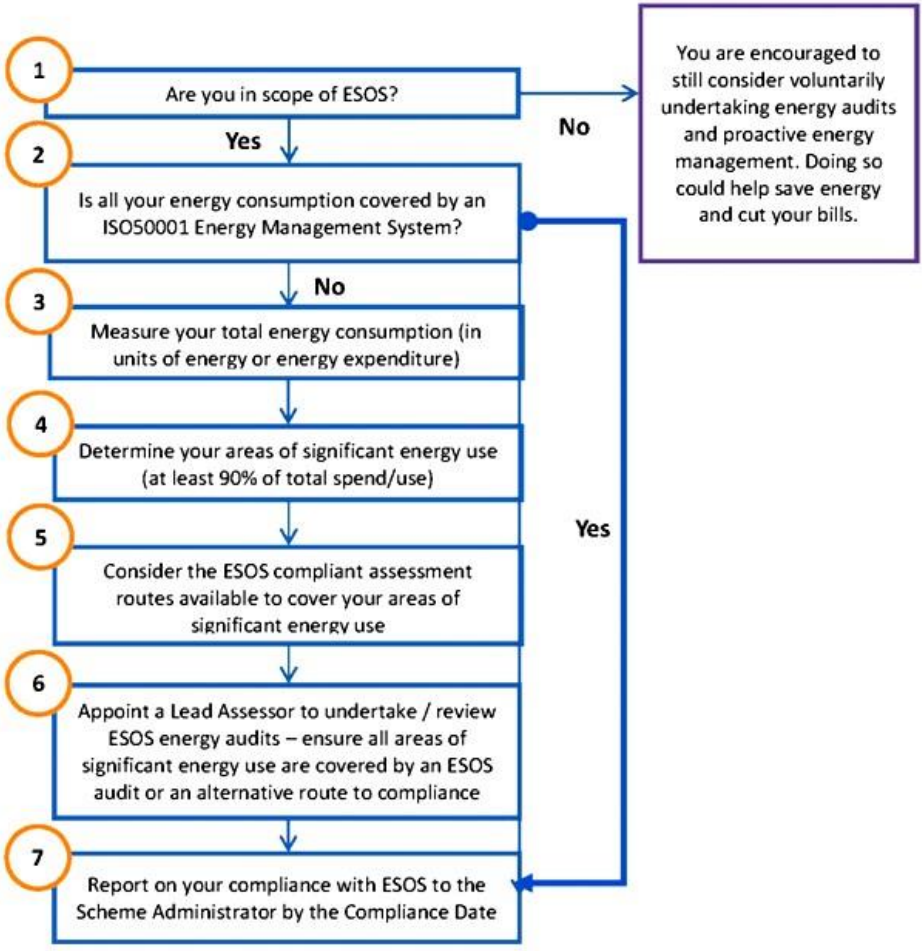
Table 1: Deadlines for Compliance

Qualification date	Four-year	Compliance date	Description
31st December 2014	6th December 2011 - 5th December 2015	5th December 2015	By 5th December 2015, qualifying organisations must carry out theor ESOS assessment and notify the Environment Agency.
31st December 2018	6th December 2015 - 5th December 2019	5th December 2019	Participants must then carry out an ESOS assessment in each four year compliance period, ending on 5th December 2019.
31st December 2022	6th December 2019 - 5th December 2023	5th December 2023	Participants must then carry out an ESOS assessment in each four year compliance period, ending on 5th December 2023 and so on.
By the end of 2014 the Environment Agency will provide information about the online notification system and when it will be available.			

3.93 ESOS Compliance Stages

The stages to comply with ESOS assessment is described in Figure 5.

Figure 5: Key steps to complying with ESOS



3.94 To calculate total energy consumption:

- General
    - Electricity, Gas, Renewables, Utilities

- Transport
    - Employee receives a supply of energy for the purposes of transport
    - Energy consumed for the purposes of transport that is on behalf of the business

- Industrial Processes
    - Industrial "energy consumption" – energy consumed by assets held or activities carried out by employees

3.95 To carry out an energy audit

There are four distinct types of qualifying assessments and management activity available:

- ESOS Energy Audits - these may include any energy audit work undertaken during the compliance period under other schemes (such as activity under the Carbon Trust Standard, Logistics Carbon Reduction Scheme and Green Fleet Reviews); that is provided your Lead Assessor confirms this work meets the minimum standards required for ESOS Energy Audits).

- An ISO 50001 certified Energy Management System.

- Display Energy Certificates (DECs) and accompanying advisory reports.

- Green Deal assessments, by default do not include an EPC.

During assessment for ESOS compliance, ISO 50001, DECs and GDA will be effective but might not suffice. However, if any of the mentioned three items exist within the undertaking, those areas do not need to be reassessed. For more information please refer to section 3.97 Energy consumption not subject to audit.

3.96 Identification of energy saving opportunities

ESOS Energy Audits must be carried out by, or overseen by, recognised Lead Assessors (members of professional registers approved by the Environment Agency). These can be either in-house experts or an external individual. Lead Assessors can review audits carried out earlier in a compliance phase in order to confirm that these meet the minimum ESOS standards.

3.97 Energy consumption not subject to audit

Any energy consuming area within the company that is assessed by one of the following concepts does not need to be reassessed:

- Compliance with ISO 50001
- Display Energy Certificates
- Green Deal assessments

To notify the compliance:

1. A responsible undertaking must maintain a written record in relation to each ESOS assessment carried out by it (the "evidence pack") which includes:

    a) Records of any data used for the purposes of:

        i. The calculation of total energy consumption

        ii. The identification of areas of significant energy consumption

iii. The energy audit, including in particular the identification of energy saving opportunities

b) Evidence of the certification of any certified energy management system, and any display energy certificate or qualifying Green Deal assessment, relied on by the participant

c) Any agreement made in accordance with regulations

d) The notification given by the lead assessor

e) Any information recorded in accordance with regulations

2. The evidence pack must be kept for at least two subsequent compliance periods following the compliance period to which it relates

Breach of Regulations:

The responsible undertakings must perform certain tasks within deadlines. The following issues will conclude penalties:

1. Failure to notify
2. Failure to maintain records
3. Failure to undertake an energy audit
4. Failure to comply with notice
5. False or misleading statement

The penalties are involving in failure to comply are listed below.

1. The financial penalties of:
    - An initial penalty – £50,000, or a lesser amount as the compliance body may determine.

- A daily penalty of up to £500 for each working day the responsible undertaking remains in breach – starting on the day after the service of the compliance notice subject to a maximum of 80 working days.

2. The publication penalty.

Useful Contacts

BREEAM
www.breeam.org

Gov.UK
www.gov.uk/energy-savings-opportunity-scheme-esos

LEED
www.leed.net

RICS
www.rics.org/uk

Syntegra Energy Performance Certification
www.syntegra-epc.co.uk/services-we-offer/energy-certification

The Planning Portal
www.planningportal.gov.uk

4 - Sustainable Energy Options

In this section we consider the technologies being employed for sustainable power and heat generation and how they fulfil the needs of the business and provide a long term revenue stream from selling excess energy to the Grid.

"In reality, studies show that investments to spur renewable energy and boost energy efficiency generate far more jobs than oil and coal."

Jeff Goodell
(Rolling Stone Journalist and Environmental Writer)

4.1 What Qualifies as Sustainable Energy?

Zero carbon energy technologies harness the Earth's abundant natural sources and convert it to electricity, heating and hot water etc., to be consumed in buildings.

Solar, wind, wave, tide and bio energy are all termed as renewable and are individually classified as 'active' or 'passive' depending on how they are harnessed.

Active Renewable Energy Sources (RES) are the renewable sources which with the use of Renewable Energy Systems Technology (REST) can generate power and heat to satisfy the energy and heating demands of buildings resulting in lower fuel consumption, reduced greenhouse gas emissions and pollution. Solar PV and wind energy are examples of Active REST by harnessing the sun's radiance and wind to generate heat and power.

Passive RES are the renewable sources which with the use of static building elements can enhance the natural ventilation and the heating of a building by using a building's windows, walls, ceiling, floors, exterior building elements and landscaping to manage the heat generated by sun. Natural processes like reflections, radiation, conduction and convection are maximised in passive solar harnessing building design.

4.2 The UK Electricity from Renewables Commitment

The UK is on target to achieve a commitment to 15% of all electricity generation, heat and transport from renewable resources by 2020, as the growth of renewable energy in the UK is increasing rapidly.

Figures for the year July 2011-12 show an increase of 27% in renewable electricity generation with capacity growing by 40% up to 14.4 GW over the same period the year before.[9] Offshore wind power increased by 60% and there was a fivefold increase in solar PV capacity.

4.3 Solar Energy

Solar energy is the energy of sunlight. The temperature of the Sun's surface reaches a value of approximately 5,762 K. The Earth‘s perimeter of 40,000km results in an intersected sun power of 174,000 TW. Attenuation by the atmosphere results in peak intensity at sea level of around 1kW/m2, giving a 24 hour annual average of 0.2 kW/m2 and 24 hour annual average power of 102,000 TW.

This commands the environment and maintains the life support system of Earth's ecosystem and all forms of renewable energy with the exception of geothermal energy. The solar energy reaching the Earth‘s surface surpasses 10,000 times the current global energy demand, so the potential to meet growing demands is limitless by today’s standards.

In terms of harnessing solar energy we are interested in, is the irradiance. Irradiance is the energy of light incident on a solar collector which is measured in energy per area (W/m2). The solar irradiance received on the Earth's surface consists of three components, the beam irradiance, diffuse and ground reflected irradiance. The beam component is the irradiance that reaches the solar collector directly. The diffuse irradiance is formulated due to scattering and absorption in the Earth‘s atmosphere. Finally, the ground reflected irradiance is formed due to the sunlight reflected by the Earth's ground.

[9] DECC (2012) Digest of UK Energy Statistics (DUKES) published 26 July 2012

For practical purposes, there are two primary types of solar power generated by harnessing the sun's light; photovoltaic (solar PV) and solar thermal.

4.4 Solar PV

Solar PV systems are composed of photovoltaic cells, usually a thin wafer or strip of semiconductor material that generates a small current when sunlight strikes them. Multiple cells can be assembled into modules that can be wired in an array of any size.

Photovoltaic solar uses semiconductor technology to convert light directly into electricity. Direct Current (DC) can be used in conjunction with an inverter to convert to an Alternating Current (AC) current. Modern PV systems can operate independently of mains supply. They can generate electricity that can either be stored in solar power batteries or sold back to the Grid, producing no greenhouse gas and saving approximately 325 kg per kW(p) generated.

Flat-plate PV arrays can be mounted at a fixed angle facing south, or mounted on a tracking device that follows the sun capturing most sunlight over the course of a day. Several connected PV arrays can provide enough power for a household/building.

Thin film solar cells use layers of semiconductor materials only a few micrometres thick. Thin film technology enables solar cells to double as rooftop shingles, roof tiles, building façades, or the glazing for skylights or atria. The solar cell version of items such as shingles offer the same protection and durability as ordinary asphalt shingles.

4.5 Solar PV Costs and ROI

Installed costs of PV systems have reduced significantly over the last two years and are continuing to fall, driven by falling PV module costs worldwide and by increasing maturity and competition in the UK market. Once installed, a solar PV power system will require little or no maintenance, potentially providing heat and electricity quietly and cleanly for 25-40 years.

Typically, the cost for a commercial solar PV installation varies depending on the size of the system required. For example, a 15 kW(p) costs around £20,000 and a 50 kW(p) costs around £57,000.[10]

However the cost of solar PV varies considerably with solar tiles and costing more than panels and depending on how and where they are mounted.

Technology	Scale	Standard Generation tariff	Multi-installation tariff	Tariff energy efficiency req. not met
PV	≤ 4kW (new build)	16	14.4	7.1
PV	≤ 4kW (new build)	16	14.4	7.1
PV	≥4-10kW	14.5	13.05	7.1
PV	Stand-alone System	7.1	N/A	N/A

Table 2: Tariff levels for new solar PV installations after August 1st 2012 (pence/kWh)

Government incentives like Feed-in Tariffs (FITS) and the decrease in costs of solar equipment mean that solar power is a sound investment generating both long-term energy and cost savings with a quick payback on capital investment.

[10] 2013 MBS

Your return on investment (ROI) relies on factors such as initial cost, grants, loans and incentives. When you build these factors into your ROI calculation, current industry research shows you could receive an 8%-15% return. Solar PV installations also qualify under the new Green Deal.

4.6 Solar Thermal

Solar thermal technologies are divided into three classes; low-temperature collectors are flat plates generally used to heat swimming pools. Medium-temperature collectors that are usually flat plates used for heating water or air for residential and commercial use and high-temperature collectors also called concentrating collectors.

4.7 Concentrating Solar Power

Concentrating Solar Power technologies (CSP) use mirrors to reflect and concentrate sunlight onto receivers that collect solar energy and convert it to heat. This thermal energy can then be used to produce electricity via a steam turbine or heat engine that drives a generator and promises a utility-scale, renewable energy option that can help meet the demand for electricity and carbon reduction targets.

Smaller CSP systems can be located directly where power is needed. For example, single dish/engine system scan produce 3-25 kW of power and are well suited for distributed applications.

4.8 Non-Concentrating Solar Power

Non-concentrating (medium temperature) collectors use mirrors to concentrate sunlight to generate heat. The most common collector is called a flat-plate collector. Mounted on the roof, it consists of a thin, flat, rectangular box with a transparent cover that faces the sun. Small tubes run through the box and carry the fluid – either water or other fluid, such as an antifreeze solution – to be heated. The tubes are attached to an absorber plate, which is painted black to absorb the most heat. As heat builds up in the collector, it heats the fluid passing through the tubes. The heat generated is most likely to be either used directly to provide hot water or heating, but it can be used to drive a heat cycle like a Stirling engine to generate electricity.

Depending on the weather conditions, non-concentrating solar collector can meet normal demand for hot water the temperature achieved can be from tepid to close to boiling. Most solar systems are meant to furnish 20%-85% of the annual demand for hot water, the remainder being met by conventional heating sources, which either raise the temperature of the water further or provide hot water when the solar water heating system cannot meet demand. Solar systems can be used wherever moderately hot water is required.

4.9 Solar PV and Thermal Summary

Both PV and thermal solar technologies require similar level of investment but solar thermal has the potential to be used as power and heat source 24 hours a day because the thermal energy it creates and is a highly efficient and cost effective solution. A typical system for a home or small business premises costs around £4,800 to install (including VAT).

You will make significant carbon savings too, of around 230 kg CO_2/year when replacing a gas system and 510 kg CO_2/year when replacing electric immersion heating.

As well as saving on your energy bills, you could also be eligible for Renewable Heat Incentive (RHI) payments for every unit of energy you generate. Solar thermal collectors are included in the government's non-domestic RHI scheme – offering payments to the owner of the heat installation over a 20 year period.

The current tariff for non-domestic solar collectors (of less than 200 kWth) is currently 10.0p/kWh, however if the application has an accreditation date prior to 21st January 2013, then the tariff stands at 9.4p/kWh. Solar Thermal installations also qualify under the new Green Deal.

4.10 Wind Turbines

Figure 6: Wind Turbines at Fullabrook Wind Farm, North Devon

Source: ©Kevin Knight 2014.

The UK is the windiest area of Europe and wind power promises to make a significant contribution to meeting targets for renewable energy with the Sustainable Development Commission estimating the practical potential is for it to provide almost 50% of the UK's consumption.

Wind turbines convert kinetic energy from the wind into electricity and are now available in a wide array of sizes from commercial wind turbines such as used to generate power for the National Grid right down to small devices for example mounted on a boat to top-up batteries.

There are two types of wind turbines, the Horizontal Axis Wind Turbine (HAWT), which is the most common, efficient and cost effective and the vertical axis turbine. Most wind turbines used for electricity generation use HAWT technology. Building-mounted turbines tend to produce less electricity per kW than pole-mounted ones. A well-sited 6 kW turbine can generate around 10,000kWh and the equivalent of around 5.2 tonnes of carbon dioxide (CO_2) a year.

Wind turbines can be found in many sizes and outputs, from small battery charging turbines (1-2 meter rotor diameter and an output of a few hundred Watts) to machines used to supply electricity to the grid with rotor diameters in excess of 70m and output powers of over 2 MW.

Figure 7: Fullabrook Wind Farm, North Devon

Source: ©Kevin Knight 2014.

Part of the electricity substation set-up; the distribution circuit breakers. These isolate the inbound power from the transformer or the converted power outbound to the electricity supply.

For business use, the options are either a pole or building a mounted system. Typically a building mounted system will be cheaper to buy and install (circa £3,000), but generate less power, depending on the size, location and surrounding environment.

Mast mounted turbines are significantly more expensive (£10-20,000) but costs vary depending on the type of system and location. Costs of equipment and installation are subject to VAT but at a 5% rate in the UK.

A properly maintained wind turbine should last 20 years and typical maintenance requirements include servicing every few years, with a possible need to replace the inverter. If batteries are used, then these will need replacing every 6-10 years.

ROI is approximately 11-12 years with wind turbines eligible for the UK government's FITs meaning you can earn money from the electricity generated and receive payments for unused electricity exported to the local grid. To be eligible, the installer and wind turbine product must be certified under the Micro-generation Certification Scheme (MCS).[11]

Domestic and non-domestic wind turbine installations qualify under the new Green Deal.

[11] The MCS is the body responsible for the approval of renewable energy products and the accreditation of renewable energy suppliers and installers

4.11 Biomass Power Generation

The principle behind the biomass carbon cycle i.e. growing and using wood and other biomass sources is simple, the plants absorb CO_2 during their growth and this is then released and returned to atmosphere when the fuel is burnt (direct combustion), or is converted into a secondary liquid or gaseous fuel using a fuel conversion process (see Anaerobic Digestion section 4.12), creating methane gas which can then be burnt to generate power or used for heating.

Biomass is a renewable energy resource providing what is used is replanted. The most common fuel currently used is short-rotation coppice typically fast growing trees. Wood waste from the timber industry, forestry and residue from other crops are often made into fuel pellets.

At the grid scale the Government is using the Renewable Obligation scheme to promote the development of large-scale integrated biomass generation. Because of the ease and low-risk of retrofitting fossil-fuel power plants to enable 'co-firing' (where both fossil and biomass fuels are used together), most of the initial expansion was in the area of existing power stations.

As the production and delivery of biomass at an industrial scale has become more refined, we are starting to witness a growth of the dedicated biomass power plant. Large scale providers are also increasingly using municipal waste previously destined for landfill sites as fuel giving a double eco benefit. For industrial scale or use in district schemes, biomass is well proven to provide combined heat and power (CHP). At domestic level, however, the use of biomass other than for heating[12] i.e. for power generation or CHP is underdeveloped with few technologies available and those that are, requiring daily manual fuel loading.

[12] See also *Biomass Heating*

Biomass boilers consist of a boiler, heat distribution system, and a fuel transportation system. They can be divided into three primary types: large scale commercial power generators, medium size power generators that typically service the needs of schools and housing schemes, and thirdly small scale domestic power generators for small business use.

The biomass heating system typically makes use of multiple heat sources, including waste heat recovery system, biomass combustion system, peak load boiler and a back-up boiler.

The heat distribution system conveys hot water or steam from the heating plant to the loads that may be located within the same building as the heating plant, as in a system for a single institutional or industrial building or a cluster of buildings known as a district heating system.

The cost of a biomass installation and running costs vary considerably depending on the type of boiler and the fuel type. It is estimated that if the UK wants to meet its carbon reduction targets, the use of these heat networks must increase 30 fold between 2013-2050.

There are a number of grants from various sources, typically ranging upwards from around £25-25,000, specialist loans and other finance schemes available to support biomass installations for non-domestic use.

The RHI provides annual subsidy payments over 20 years for the generation of heating by renewable technologies at a level designed to remove the barriers of installation. Those generating heat and hot water from heat pumps, solar-thermal solutions, biomass and bio-methane boilers can be paid up to 8.5p/kWh under the RHI with the annual subsidy lasting for 20 years.

According to the Government's set tariff levels, users will earn a return of around 12% per annum but initial industry estimates are closer to 6%-9%. This could still provide a return on investment within 5-10 years.

4.12 Anaerobic Digestion (AD)

AD is a natural process in which bacteria breakdown organic matter in an oxygen-free environment to form biogas and digestate. AD occurs naturally in marshes and stagnant pools and landfill sites. A broad range of organic inputs can be used including manure, food waste, and sewage, although the composition is determined by the industry, whether it is agriculture, industrial, wastewater treatment or others.[13]

Anaerobic digesters can be designed for either mesophilic or thermophilic operation – at 35°C (95°F) or 55°C (131°F), respectively. Temperatures are carefully regulated during the digestion process to keep the mesophilic or thermophilic bacteria alive. The resulting biogas is combustible and can be used for heating and electricity generation, or can be upgraded to renewable natural gas and used to power vehicles or supplement the natural gas supply. Digestate can be used as fertilizer.

4.13 AD Process

AD has a defined process flow that consists of four distinct phases: pre-treatment, digestion, biogas processing and utilization, and disposal or reuse of solid waste.

[13] Centre for Climate Change and Energy Solutions

1. In pre-treatment, wastes may be processed, separated, or mixed to ensure that they will decompose in the digester.

2. During digestion, waste products are broken down by bacteria and biogas is produced.

3. Biogas produced is either combusted or upgraded and then utilised to displace fossil fuels. During upgrading, scrubbers, membranes, or other means are used to remove impurities and CO_2 from biogas.

4. Reuse or disposal of solid digested waste. Digested waste has a high nutrient content and can be used as fertilizer so long as it is free of pathogens or toxins, or it can be composted to further enhance nutrient content.

4.14 Types of Anaerobic Digesters

Though there are many different types of digesters that can be used for agricultural, industrial and wastewater treatment facility wastes, digesters can be broadly grouped based on their ability to process liquid or solid waste types. It is a process whereby bacteria breakdown organic material in silos in the absence of air, yielding biogases (methane and CO_2), a solid residue similar to compost and liquid that is often used as fertilizer.

Another type is bio-SGN made from gasification of dry materials. This alternative fuel source represents an affordable and renewable solution for space, water and process heating, if injected into the gas network, without the need for changes to infrastructure or appliances whilst also potentially reducing the amount of waste sent to landfill.

The Gas Distribution Networks (GDNs) are committed to maximising the opportunities to use Biomethane and other renewable gas sources in the UK. So far there have been two successful projects now injecting Biomethane into the grid – Didcot Sewage Works (Scotia Gas Networks), and Adnams Brewery (National Grid) with many more in the planning stages.

4.15 Anaerobic Generation Facts

- Anaerobic digesters provide a variety of environmental and public health benefits including: greenhouse gas abatement, organic waste reduction, odour reduction and pathogen destruction.

- Anaerobic digestion is a carbon-neutral technology to produce biogas that can be used for heating, generating electricity, mechanical energy or for supplementing the natural gas supply.

- In 2010, 162 anaerobic digesters generated 453 million kWh of energy in the United States in agricultural operations, enough to power 25,000 average-sized homes.

- In Europe, anaerobic digesters are used to convert agricultural, industrial and municipal wastes into biogases that can be upgraded to 97% pure methane as a natural gas substitute or to generate electricity.

- Germany leads the European nations with 6,800 large-scale anaerobic digesters, followed by Austria with 551.

- In developing countries, small-scale anaerobic digesters are used to meet the heating and cooking needs of individual

rural communities. China has an estimated 8 million anaerobic digesters while Nepal has 50,000.

In controlled AD processes, liquid materials that can be pumped to the anaerobic digester have an unexploited energy value – anaerobic treatment will reduce treatment costs and the carbon footprint of the site. The methane gas component can be burnt to drive turbines and create clean electricity.

4.16 Combined Heat & Power (CHP) from Anaerobic Digestion (AD)

At present, in most AD plants, renewable electricity is generated from CHP engines, along with surplus heat. Generated electricity can either be used on-site (to replace bought-in power) or sold to the National Power Grid at a premium over purchased electricity costs. By generating renewable energy, on-site AD will reduce treatment costs and replace fossil fuel derived energy, and reduce the carbon footprint of the site.

The renewable electricity FIT was extended with two additional FIT bands in 2011 to provide higher rates for gas combustion in a CHP generator from smaller scale AD.

These index-linked payments are now set at 15.16 per kW for plants producing less than 250 kW and 14.02 for 250-500 kW, and 9.24p per kW for plants that generate over 500 kW. In addition, there is a payment of at least 4.5p per kW when electricity is exported to the grid. There will be regression for the value of FIT payments (possibly by 2.5% each year) for plants that were registered after April 2014.

Also, to encourage the use of renewable heat, the Renewable Heat Incentive (RHI) was introduced in November 2011. It too is index-linked and now provides a payment of 7.3p per kW of heat value, for biogas that is up-graded to bio-methane for injection into the gas grid.

The RHI is also available for direct use of biogas – up to 200 kW, for the surplus thermal energy from biogas that is fed to a CHP unit or if it is used in a biogas boiler. DECC brought a second phase of the RHI in April 2014 for heat from direct (on-site) use of biogas over 200 kW thermal.

AD has potential as an option for a district heating system, with excess electricity being fed into the grid and creating a sustainable and secure local heating and power solution.

4.17 Small Scale Anaerobic Digestion (AD) Applications

Anaerobic generation can be utilised for smaller scale industries where onsite liquid waste residues that contain sugars, oils and fats, plus rejected product or ingredients that can be digested and turned into biogas to generate energy. Typical industries where small scale Anaerobic Treatment Plants are capable of processing from 70 cubic metres a day, include speciality food producers, dairies and cheese-makers, microbreweries, small distillers and industrial sites including for healthcare.

The Treatment Plant generates biogas that be used on-site and will qualify for the FIT and RHI payments. The Phase 1 RHI pays 7.1p per kW for plants that produce less than 200 kW of heat energy from a dedicated biogas boiler. On some smaller sites a CHP unit may also be an option.

Claimed ROI for Anaerobic Treatment Plant is around 6 years, and there are now rental and other financing options available to make this practical for smaller businesses.

4.18 Hydroelectric

The total hydroelectric installed capacity in the UK at the end of 2011 was approximately 1676 megawatts (MW), which is around 1.9% of the current total UK generating capacity and 14% of renewable electricity generation capacity.[14]

Recent studies estimate there is a remaining viable hydro potential of 850 - 1550 MW in the UK. This represents a further, approximately 1%-2% of current UK generating capacity; so would make a modest but useful contribution to UK renewable energy and emission reduction targets.

Most of the large scale schemes are based in the Scottish Highlands, and although further large-scale development potential is limited by large-scale suitable water resources, there is considerable scope for exploiting our remaining small-scale hydro resources in a sustainable way.

There are three main types of Hydro Scheme in use in the UK:

1. Storage Schemes - in storage schemes, a dam impounds water in a reservoir that feeds the turbine and generator that are usually located within the dam itself.

2. Run-of-river Schemes - these use the natural flow of the river, where a weir can enhance the continuity of the flow. Both storage and run-of-river schemes can be diversion schemes, where water is channelled from a river, lake or dammed reservoir to a remote powerhouse containing the turbine and generator.

[14] UK.Gov

3. Pumped Storage - this incorporates two reservoirs. At times of low demand, normally at night, electricity is used to pump water from the lower to the upper basin. This water is then released to create power at a time when demand and therefore price, is high. Although not considered a renewable energy (because of its reliance on electricity), pumped storage is very good for improving overall energy efficiency.

4.19 Defining Hydroelectric Output

There are three main categories used to define the output from hydroelectric power:

1. Large-scale capacity – hydro plant producing more than 5 MW.

2. Small-scale capacity – hydro plant producing less than 5 MW.

3. Micro-scale capacity – hydro plant producing less than 50 Kw.

4.20 Small (micro) Hydro Schemes

Small hydro systems are very efficient, have long life potential and a long established record as a technology with over 100 years in use. They are however site-specific, requiring a source or moving water (stream or river) to convert potential and kinetic energy into electricity.

The majority of micro-hydro schemes employ 'run-of-the-river' (ROR) designs using water that is available at any instant in the watercourse with little or no storage behind the dam for later use. The river flow is diverted through turbines that spin generators before returning the water back to the river downstream often defined as low-head and high-head schemes. Low-head has a total water drop somewhere in the region of 2-5m and high-head can use anything up to hundreds of metres.

As the energy generated is directly proportional to the flow rate of the water and the head height, so for small residential schemes constant and long-term reliable flow of water is critical.

4.21 Small Hydro Scheme ROI

Most of the cost of small-scale hydro schemes is upfront with the payback over many years. Low heat systems costs around £4,000 per kW installed up to about 10 kW and drop to around £3,000 pro-rata per kW for larger projects. For medium heads, there is a fixed cost of about £10,000 and about £2,500 per kW up to around 10 kW; so a typical 5 kW domestic scheme might cost £20-£25,000.

There are a number of steps that have to be considered before a scheme can be built, e.g. scheme economics, environmental permits, planning consent and connection to the local electricity network.

FITs have been available since April 2010 to reward renewable electricity generation. These tariffs provide a further incentive, but installers must consider issues such as protecting wildlife and fish, which may mean including additional features in the scheme design. As hydro schemes require planning permission, it is a good idea to involve the Local Authority to get their specialist advice before undertaking a feasibility study.

Once established hydro systems are extremely reliable and robust, with potential life-span of 30 years or more, during which time they can generate electricity to sell to the grid or off-grid to power homes or businesses.

4.22 Fuel Cell Technologies

A fuel cell is a device that generates electricity by a chemical reaction. Fuel cell power is described as ultra-clean, efficient and reliable. One great appeal of fuel cells is that as they generate electricity they give off very little pollution. Since much of the hydrogen and oxygen used in the process combines to form water as the main bi-product, fuel cells are amongst the most promising technologies in current research for new clean-energy solutions.

Every fuel cell has two electrodes, one positive and one negative, called the anode and cathode, respectively. The reactions that produce electricity take place at the electrodes. Every fuel cell also has an electrolyte, which carries electrically charged particles from one electrode to the other, and a catalyst, which speeds the reactions at the electrodes.

A fuel cell combines hydrogen and oxygen to produce electricity, heat, and water. Fuel cells are often compared to batteries. Both convert the energy produced by a chemical reaction into usable electric power. However, the fuel cell will produce electricity as long as fuel (hydrogen) is supplied; never losing its charge.[15]

[15] Renewable Energy World

4.23 Future Applications

Fuel cells operate best on pure hydrogen. However, fuels like natural gas, methanol, or even gasoline can be reformed to produce the hydrogen required for fuel cells. Some fuel cells can even be fuelled directly with methanol, without using a reformer.

In the future, hydrogen could also join electricity as an important energy carrier. An energy carrier moves and delivers energy in a usable form to consumers. Renewable energy sources, like the sun and wind, can't produce energy all the time. However, they could, for example, produce electric energy and hydrogen, which can be stored until it is required. Hydrogen can also be transported (like electricity) to locations where it is needed. Fuel cells are a promising technology for use as a source of heat and electricity for buildings and as an electrical power source for electric motors propelling vehicles.

4.24 Leading the Way

The quiet operation and virtual lack of pollutants from fuel cells make them well suited for populated areas like major cities. In 2103, a molten carbonate fuel cell power plant was installed at the 690,000 sq. ft. 38 storey combined office and retail development at 20 Fenchurch Street in central London, UK providing an electrical output of 300 kW, enough to power almost 800 average UK households.

The fuel cell is at the heart of the building sustainability strategy, providing electricity and heat in a CHP configuration. This is with high-temperature heat provided to an absorption chiller for cooling, and lower-temperature heat for the facility and hot water heating.

The fuel cell in the Fenchurch Street development is the first installation of its type in the City of London's Square Mile. It is envisaged that the ultra-clean and efficient power generation profile of fuel cell systems will facilitate clean-air supporting London's carbon reduction targets

4.25 Fuel Cell Costs Set to Drop

A recent study estimated that, based on the expected electricity generation mix in 2020, fuel cell micro-CHP system retrofitted to a typical family home will save between 21%-40% of GHG emissions compared to a condensing boiler.

Although still comparatively expensive, fuel cell micro-CHP systems could be used as a low emission replacement for a large proportion of household boilers or to complement to modern gas heating. Similarly to solar PV, the cost of small scale fuel cell installations are expected to fall rapidly over the next few years especially if they are included in FITS improving ROI and driving demand.

Fuel cell installations will qualify under the new Green Deal. To encourage the take-up of fuel cells as an alternative eco-energy source, the UK trade Association, UK Hydrogen and Fuel Cell Association (UKHFCA)[16] launched a campaign in 2013 calling on the Government to extend the FIT to cover fuel cells.

New micro-generation incentive payments are encouraging the deployment of fuel cell micro-CHP installations in Europe, especially Germany. In the UK however, although it is a leader in developing these technologies, only some fuel cell CHP installations are eligible for support under the Renewable Obligation.

[16] http://www.ukhfca.co.uk/

4.26 Combined Heat and Power (CHP)

CHP is a process in which both space/water heating and electricity are produced at the same time. Fuel cell technologies extend practicality of combined generation of CHP to smaller scale installations, commonly referred to as micro-CHP.

A CHP plant consists of an electrical generator combined with equipment for recovering and using the heat produced by that generator. The generator maybe a prime mover such as a gas turbine or a reciprocating engine, or it may consist of a steam turbine generating power from high-pressure steam produced in a boiler.

CHP plant is divided into four main types:[17]

1. Packaged CHP - designed and supplied as complete units that can easily be connected to a building's electrical and heating systems. Typically these units range in size from generating 50 kWe to over 1 MWe generating capacity. They are usually provided with an integrated remote monitoring and control system.

2. Custom CHP - systems designed and built to meet the specific requirements of the site and usually integrated into the site's utilities and services. Typically these schemes range in size from generating 1 MW to 100s of MWe generating capacity.

3. Micro-CHP - is simply CHP on a small scale, with the prime mover generating less than 50 kW of electricity (kWe). Although most domestic micro-CHP generate between 1-5 kWe micro-CHP units are becoming available as direct

[17] Department of Energy and Climate Change (DECC)

replacements for domestic boilers, and are eligible for support under FITS, provided the electrical capacity is 2 kWe or less.

4. Renewable CHP - the key benefit of CHP generation is that much of the heat which would otherwise be wasted from power only generation is recovered for additional uses. Thereby reducing overall fuel consumption and atmospheric emissions of greenhouse and polluting gases. Renewable CHP generation reduces further still the carbon intensity of power generation through the use of carbon neutral renewable fuels.

In many cases, industrial CHP systems primarily generate electricity, and heat is a by-product. CHP units have been operating at an industrial/community scale since the 1970s, and CHP is widely used in energy-intensive industries, such as paper mills and oil refineries. This is because large companies have the resources and long-term foresight to invest in technologies that reduce operating costs.

The European Cogeneration Directive defines micro-CHP as all units with an electrical capacity of less than 50 kW. Since 2000, with rising energy prices, micro-CHP installations designed for individual buildings have become economically viable.

Effectively, in homes or small commercial buildings, the micro-CHP unit replaces the conventional gas central heating boiler providing heat and hot water as usual. Additionally micro-CHP provides some of the building's electricity needs or, in some cases, more than its needs. In the latter case, it qualifies for sale to the grid under FITS. Connected to a district heating network, CHP can provide heat and power to multiple customers in city centres, towns, villages, industrial zones and other built environments with highly concentrated or ‘dense’ demand for heat.

Micro CHP is not classed as a renewable technology (unless fuelled by renewable biofuels) but properly applied it can reduce carbon emissions and total energy costs. It will not replace the need for connection to the mains electrical supply grid but will provide a source of electrical power that can be used directly on the premises or exported back to the grid.

Useful Contacts

British Hydropower Association
www.british-hydro.org

UK Government – Harnessing Hydropower
www.gov.uk/harnessing-hydroelectric-power

The Micro-generation Certification Scheme
www.microgenerationcertification.org

Feed-in Tariffs Scheme
www.fitariffs.co.uk

Environment Agency – Hydropower Good Practice
www.gov.uk/government/collections/hydropower-schemes-guidelines-and-applying-for-permission

UK Hydrogen and Fuel Cell Industry
www.ukhfca.co.uk

5 – Energy Management Solutions

Often remarkable savings in energy use, CO_2 emissions and costs can be made for minimal investment in simply better monitoring and management. In this section we look at the practical and often inexpensive options and their potential positive impact.

"If you want to find the secrets of the universe, think in terms of energy, frequency and vibration."

Nikola Tesla
(Serbian American inventor and mechanical and electrical engineer)

5.1 Better Energy Management Potential to Aid CO_2 Reduction

The Carbon Trust estimates that existing non-domestic building CO_2 emissions could be reduced by as much as 35% by 2020; delivering a potential £4 billion benefit to the UK economy at no net cost. Most of the improvements utilise simple, low-cost changes like heating and lighting controls, improved energy management and building utilisation.

The issue of effective power management is significant for many businesses. If the power supply is at a higher level than required, some equipment consumes more power and more power equals more costs.

5.2 Intelligent Power Management

Harmonic distortions in power supply most often generated by electronic loads can result in damage to equipment, tripping and reduce its working life. It can also significantly increase power usage and necessarily at advantageous tariffs.

Intelligent power management systems are designed to help you to take advantage of reduced tariff and incentives packages, especially if used in conjunction with onsite generation capability that enables real-time power management and will help match loads to tariffs.

Aside from the obvious financial benefits of power management technology, used effectively it will improve the site's power factor above the recognised 0.95 benchmark. It will also help to resolve any erratic power supply issues; increasing efficiency, reliability and extending the longevity of equipment.

The typical payback time for implementing power management controls ranges between 1-4 years and also will help with assessing the feasibility of the site for voltage optimisation that can lead to further significant cost benefits.

5.3 Voltage Supply Optimisation

Figure 8: Voltage Optimisation Unit

The ever rising power costs, allied to the pressure to save energy and cut business carbon emissions, means that voltage supply optimisation, maintaining voltage levels at 220 V, can be a quick and big win for many businesses.

Source: ©Marshall-Tufflex.

Most modern equipment is designed to operate at the standard European voltages of 400 V/230 V, but most facilities in UK consistently provide increased voltage 420 V/242 V or higher resulting in high power consumption, more maintenance and equipment failure.

Some voltage optimisers have a fixed voltage adjustment, whilst others can automatically and electronically regulate their supply voltages. Commercial building and industrial voltage optimisers are normally based around auto-tap-changing transformers, with advanced electronic control circuitry, whilst smaller domestic voltage optimisers often use a toroidal type transformer.

By optimising voltage supply, your business can save upwards of 5% to as much as 20% in electricity costs depending on what equipment is being used. Even higher reductions in electricity costs can be achieved when used in parallel with other power management and onsite generation technologies.

Typical payback time for Voltage Supply Optimisation can be as little as two years, and as installation work can be carried out with little disruption, it is a potential quick win for many businesses.

5.4 Uninterruptible Power Systems (UPS)

UPS helps protect your assets from damage caused by sudden power surges or outages. When systems are shut down suddenly, because for example, there is a power failure, then it often results in damaged hard drives and loss of data.

A UPS system will keep your critical load functioning properly until you have time to do a proper shutdown and also protect against power surges and sags by regulating the voltage of the incoming power supply.

Modern UPS technologies can be a key part of an ECO energy power solution, particularly when applied to Data Centres.

5.5 Higher Efficiency Motors

The running-costs of a 75 kW motor can exceed its purchase price within two months, costing over £1m in electricity over its lifetime. In fact, industrial motors currently consume an estimated that today motors consume up to 65% of industrial and up to 50% of all electricity worldwide.

Modern, higher efficiency motors that conform to the new mandatory IE2 standards are considerably more efficient, recouping their return on investment (ROI) within a few months and going on to save a small fortune over their operating life. When coupled with additional energy management options like variable speed drives (VSDs) further savings can be made.

5.6 Variable Speed Drives (VSD)

VSDs are intelligent devices that can be integrated with energy management system, optimising the voltage and frequency supply to the load demand of the motor to significantly reduce its energy consumption by between 20% to as much as 70%.

Traditional fans and pumps are hugely inefficient and consume far more energy than is required. The introduction of a VSD can, in many cases, deliver up to and between 20%-70% energy savings depending on the application. Equipment such as swimming pool pumps, air handling units and extraction systems can all use VSDs to deliver optimum performance at a fraction of the cost.

VSDs work by optimizing the voltage and frequency of supply to motors matching the speed to the actual load demand. VSDs can be integrated into an Energy Management System and are a major component in dynamic power management.

A modern motor with a matched VSD can significantly reduce energy costs and emissions, achieving a ROI in a matter of weeks. In the UK alone it is estimated that over £1m a day in wasted energy could be saved by using appropriate VSDs.

5.7 Smart Metering

Smart meters are the next generation of metering for gas and electricity that offer intelligent functions. The Government's vision is for every home in Great Britain to have smart energy meters, with businesses and public sector users also having smart or advanced energy metering suited to their needs. To implement its vision, the Government has established a central change programme - the Smart Metering Implementation Programme that will be rolled-out as standard across the UK by 2019.

For both business and domestic users smart meters provide significant benefits including the ability to see real-time power usage in actual pounds and pence being used ending estimated billing practices. This capability in turn enables people to better manage their energy consumption, save money, reduce emissions and to budget more accurately.

Importantly smart meters will also help householders and businesses to compare tariffs and switch suppliers more easily to get the best deals.

5.8 Monitoring and Targeting Systems

A monitoring and targeting system is at the heart of an effective energy management programmes and will deliver the fastest ROI.

Ideally the monitoring and targeting system will collect data from all the major loads including electricity, water, steam, gas, heat and coolness. Thus enabling problem areas to be highlighted providing key performance indicators and identifying payback opportunities.

A typical monitoring and targeting system should show where utility spend reductions between 3%-10% can be regularly achieved, often with low-cost solutions.

5.9 Building Energy Management (BEM)

An estimated 40% of all energy consumed in the UK is used by buildings so it is perhaps unsurprising that building automation is experiencing exponential growth.

The use of BEM, computer-based software for controlling and managing energy use, has risen and is now a huge market with hundreds of vendors worldwide and the European market is growing at around 15% per annum.

To ensure a building's energy performance is optimised a BEM has three critical roles to play; optimizing equipment operating schedules, improving plant control and monitoring and displaying energy consumption.

BEM is scalable for all types of commercial and public sector buildings. On average it delivers up to 30% improvement in energy use, costs and emissions. Depending on what is required from basic maintenance to a complete installation, a typical BEM can provide an ROI within a few months.

5.10 Building Automation Controls (BACS)

Many building owners are now becoming more sensitive to emissions targets, new requirements and costs, and are therefore looking for a more holistic approach to delivering and controlling their different services – heating, ventilation and air conditioning (HVAC), fire security, lighting and energy management.

Having access to high-quality data about a building's energy consumption is the key to achieve energy efficiencies. In mid-2012, BSI released a new standard; 'BS EN 15232:2012[18] Energy performance of buildings: Impact of Building Automation, Controls and Building Management'. The new standard replaces 'BS EN 15232:2007.

The new EN15232:2012 Standard has four efficiency classes A to D. After a building has been equipped with building automation and control systems it will be assigned one of these classes.
The potential savings for thermal and electrical energy can be calculated for each class based on the building type and building purpose. The values of the energy class C are used as the reference for comparing the efficiency.

Integrating such energy management functions into automated plant systems to benefit a totally automatic monitoring and targeting system (aM&T) can result in further savings.

[18] British Standards Institution

5.11 Factory and Process Automation

Process automation can significantly reduce costs, cut energy consumption and carbon emissions, reduce downtime and minimise maintenance requirements. ROI will depend on complexity and scale of automation, but savings of as much as 80% are possible through plant automation in many instances with many organisations able to benefit from optimised automated systems.

5.12 Green IT

The global growth in IT is a huge contributor to the rise in greenhouse gases. Currently the ICT industry represents 2% of global emissions, and it is estimated this will grow at a compound rate by 2020 to 2.7% of CO_2 by 2020. One comprehensive way to describe Green IT is:

"*The study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems — efficiently and effectively with minimal or no impact on the environment."*[19]

Not a catchy description maybe, but the principle is clear; manufacturers have a responsibility in the design and production of IT equipment to make it power efficient and recyclable, and users have a responsibility in how they use, manage and dispose of equipment.

[19] Sam Murgesan, "Harnessing Green IT: Principles and Practices," IEE News, Jan-Feb 2008

Every business has the option to seek to work with partners who subscribe to Green IT practice. For example, data centre and hosting companies are now increasingly using low carbon or heat recycling solutions for example in Helsinki where heat generated goes into the city's district heating system to provide hot water.

As noted earlier, for Listed UK Companies they are now subject to reporting on the Carbon Footprint just as they are their financial performance. Over the next few years this may become part and parcel of how every business is judged.

Useful Contacts

Energy Services Technology Association
www.esta.org.uk

Energy Institute
www.energyinst.org

Chartered Institution of Building Services Engineers
www.cibse.org

www.cibse.org/Networks/Groups/Information-Technology-(IT)-Controls

6 - Lighting Your Way

In this section we are reviewing the options for new, energy-efficient low-carbon emission and renewable energy lighting solutions.

“The principal person in a picture is light.”

Edouard Manet
(Painter 1832-1883)

6.1 In a Good Light

Lighting can account for up to 40% of all electricity use in buildings. It is estimated that up to 75% of buildings have outdated lighting that is not only energy inefficient, but is also not providing an optimised visual environment for occupants. With so many buildings using outdated ineffective lighting, the overall scale of the potential electricity savings is huge. A 10% reduction in lighting use in the non-domestic sector would reduce carbon emissions by 2.4 mTCO2 equivalent.

The fact is that many existing building occupants have inherited lighting along with their building, and often little consideration has given to improving the lighting to adapt to the new tasks or take advantage of technical advancements achieved in recent years.

6.2 Low Energy Lighting

Low energy lighting can be divided into two primary technologies: LED and T5 Fluorescent.

The LED abbreviation stands for Light Emitting Diode. The LED is an electromagnetic light source, and it is estimated that LED bulbs use as little as 5% of electricity compared with a traditional bulb. So energy efficient lighting not only contributes to a better environment but also saves huge energy costs.

The main advantages of LEDs compared to other light source technologies are:

- Increased lifetime from 50,000 up to 100,000 hours of operation

- Highly energy efficient – capable of reaching 140 lumen/Watts

- Transmit very low or negligible amount of heat

- Are a low carbon technology therefore greener than other lighting technologies

LED technology is greener than conventional lighting because they do not contain any harmful or toxic substances, such as mercury (fluorescent lamps). In addition, LEDs neither emit any damaging radiation nor do they create an electromagnetic field.

LED lighting has many benefits, including low energy consumption, the extended lamp life with little maintenance, insensitivity to vibration, little infra-red or ultra-violet radiation and the opportunity of white and coloured sources for different applications.

The compact design means instant flicker-free light that can be designed into virtually all lighting applications. LED is most cost effective solution wherever 24/12 hour lighting is needed. This assumption is based on the 50,000 hours usage guarantee that leading LED manufacturers give for their products.

The 50,000 hours is translated into 6.5 years of 24 hour lighting, giving a return on investment (ROI) after the first two years and a further saving of 45%-55% over the next 4.5 years.

6.3 T5 Fluorescent lighting

T5 lighting is a low energy replacement for older fluorescent lighting and in some cases an alternative to LED.

The T5 light was introduced in the American market in 1995 and has continuously gained popularity both as a high performing and low-cost lighting solution. In 2009, the Institute of Electrical Engineers (IEEE) compared the heat dissipation and thermal degradation efficacy between T5 and LED bulbs. They discovered that T5 bulbs perform significantly better than LED bulbs.

Whilst T5 solutions have become more prevalent in commercial installations for their increased performance, the issues of maintenance and dimming require consideration.

6.4 Solar Lighting

Solar lighting use photovoltaic technology to convert sunlight into a DC current that is used to power the light and is stored in long lasting batteries - typically sufficient to operate the light array for around five days without daylight. Solar lighting is virtually maintenance free and with their batteries are unaffected by power cuts, lack of sunlight or the night time.

Figure 9: Solar Powered School

Source: © Timrobertsaerial | Dreamstime.com - Solar Powered School Photo.

Solar lights are becoming ever more popular and are in wide-spread use particularly for lighting public areas – roadways, car parks, industrial complexes and many other large scale uses. They are also highly versatile, ideal for signage use and temporary lights or to light areas where access to grid power is limited. Moreover, in environmentally sensitive areas a solar lighting installation minimises the impact on the surroundings and creates zero carbon emissions.

Typical solar solutions will be a comparable capital cost to conventional on-grid solutions, i.e. when the groundwork's, wiring and transformer that are required are accounted for. However, a typical solar installation takes only a few weeks from initial commitment to being a fully installed system. The big payback though is that solar lights require no external power source, and once installed they entirely eliminate energy costs. Free lighting for many years to come with an average expected life-span of 20 years or more.

6.5 Intelligent Lighting Control

Lighting controls offer significant opportunities for energy management including occupancy sensors that dim or switch off lighting when no one is in the room and reduce electricity use by up to 30%. Additionally, daylight sensors adjust room light to take account of the amount of ambient natural light, and can significantly reduce overall power use as up to 40% your building's electricity use is accounted for by lighting.

The right level and quality of light improves the alertness and accuracy of those working in it. In considering whether to implement a new energy efficient lighting solution, consideration should be given not only to the reduced running costs and emissions it can deliver, but also to its potential to significantly improved working environment with a positive effect on staff morale and productivity.
To get maximum benefit from a new lighting solution it is important to consult an expert to advice on suitable lighting controls and ensure that the installations will meet with the visual requirements of the building's occupants.

For best results, it is vital that your building's occupants understand how lighting controls operate, and there is a regular cleaning and maintenance plan to include window the lamp fixtures (luminaries) and windows to maximise natural light.

Useful Contacts

Carbon Trust
www.carbontrust.com

7 – Building Fabric and Insulation

"You cannot simply put something new into a place. You have to absorb what you see around you, what exists on the land, and then use that knowledge along with contemporary thinking to interpret what you see."

Tadao Ando
(Architect)

7.1 Form, Fashion and Functionality

The fabric of a building: its ceiling, walls, doors windows and floors, what they are made of; how they are put together and what materials are used. These are the leading factors in defining both the presence of the building in the landscape and its efficiency in meeting its purpose.

According to a Carbon Trust assessment, on average around 60% of building heat is lost through poor insulation. Significant heat conservation gains from existing buildings may only be cost effective if they are planned as part of larger scale refurbishment projects. Smaller gains though can often be made through fairly simple measures.

7.2 Effect of the Energy Bill

The current proposed Energy Bill if passed will mean that from April 2016 onwards, landlords will not be able to refuse reasonable requests from tenants, or local authorities acting on behalf of tenants, to improve their property.

Additionally, from April 2018 the government will make it unlawful to rent out a house or business premise which has less than an “E” energy efficiency rating, ensuring at least 682,000 properties will have to be improved.

7.3 Loft Insulation

Loft space insulation is one of the simplest measures that can be taken to improve the performance of existing properties. Once installed it is effective for at least 40 years, and it will pay for itself many times over the years. The Energy Saving Trust estimate that in an uninsulated home up to 25% of heat is lost through the roof.

7.4 Wall Insulation

Buildings have two types of walls, a solid wall for example a brick or stone wall, or a cavity wall made of two layers with a cavity in between. Solid walls can be insulated either from the outside of the inside. Internal wall insulation is done by fitting rigid insulation boards to the wall, or by building a stud wall filled in with mineral wool fibre. Insulation can also be allocated around building services e.g. ventilation ductwork.

Figure 10: Fiberglass for New Factory

Source: © Wittybear | Dreamstime.com - Fiberglass for New Factory Construction Photo

External wall insulation involves fixing a layer of insulation material to the wall, then covering it with a special type of render (plasterwork) or cladding. The finish can be smooth, textured, painted, tiled, panelled, pebble-dashed or finished with brick slips. External installation is often cheaper to install than internal. Cavity walls can be insulated internally using mineral wool, beads of granules and foamed insulants. Foam insulation systems should be certified by the British Board of Agrémont and installed in accordance with BBA Certificate guidance.

7.5 Optimised Window Glazing

Energy efficient glass that captures energy from daylight and reduces energy bills, the Building Regulations regarding the type of glass used in construction are laid out in Document L 2013 - Conservation of fuel and power.[20]

Part L1a refers to a minimum U value performance for windows of 1.4 W/m^2K, walls – 0.18 W/m^2K, roofs – 0.13 W/m^2K and floors 0.13 – W/m^2K. However this is used mainly to allow flexibility in design and reduce the likelihood of condensation build up on glass.

This new specification has been strengthened to deliver a 6% improvement across new home builds relative to the previous 2010 Part L1a specification. The calculation method to be used will be the new SAP 2012. The limiting fabric parameters for glazing and window performance remain the same as 2010 at 2.0 W/m^2K to allow for design flexibility, however the 'Model Design' specified in Part L1a recommends a whole window U value of 1.4 W/m^2K with a g value up to 63% to avoid overheating. This performance is easily achieved by using

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www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/changes

ClimaGuard A 1.0 or by using one of our Sun Guard Super Neutral or eXtra Selective glass options.

7.6 New Build Materials & Methods

7.61 Green Roofs

A green roof is a living deck or roof structure upon which vegetation is grown. They are not a new innovation, and turf roofs were historically common in Northern Europe with countries like Switzerland and Austria having a long tradition of using them. They were also used extensively in Berlin in the 19th century and continued to be used on large scale constructions in the 20th Century.[21] Other countries including Japan, The USA and Canada have more recently begun to adopt green roof use to gain from its significant insulation advantages.

The most famous UK green roof buildings include Kensington Roof Gardens covering 6,000 sq. m roof of the former Derry & Toms department store built in 1993 and the Sir Norman Foster designed Willis building in Ipswich.

Green roofs are partially or completely covered with vegetation planted over manmade waterproof membranes, so as well as being a sustainable roofing solution, they also have an aesthetic impact.

[21] http://www.greenroofguide.co.uk/what-are-green-roofs

Each roof is different and depending on the vegetation which varies, however all offer significant insulation, water retention, pollution-filtering and noise reduction properties. Green roofs retain up to 80% of rainfall during summer and 40% in winter, this is turn leads to lower water run-off and drainage and reduced energy costs.

Due to the increased emphasis on sustainable development there has been an overall rise in interest in the use green roofs in the UK over the last decade. Not only do they offer green urban spaces but can be a factor in reducing the Urban Heat Island Effect which can be as high as $5^{o}C$. It is estimated there is in excess of 200 million metre sq. of UK roof spaces that could be 'greened' with few other modifications required to over them.

Recognising both the environmental and economic benefits of green roofs, Sheffield Council has led the way with a Green Roof Policy, requiring larger developments (over 1000 sq. m gross internal footage) to have at least 80% green cover over the total roof area.[22]

7.62 Brown Roofs

Brown roofs are very similar to green roofs except they are less formal and take time to mature once installed, tending to use soil, crushed brick, gravel or rubble and other locally sourced materials to form the base. Brown roofs are not formally planted and, once completed, then 'Nature takes her course,' evolving an ecosystem to become a natural haven for local wildlife wild flowers and plants.

[22] Sheffield Development Framework - Climate Change and Design

Supplementary Planning Document and Practice Guide

7.63 Green Roofs versus Brown Roofs

Living roofs whether green or brown both offer similar benefits and have similar values in terms of noise reduction, water retention and reduced energy costs. The selection of which is the most appropriate solution for a specific project, largely, comes down to costs, aesthetics and the local environment. Where an 'instant green effect' is wanted then a green roof, planted with a suitable combination of plant species will provide an instant finished look and be cheaper to maintain in the early years but tends to cost £10-12 more per sq. m to install compared to brown roof.

Typically a brown roof will take several years to mature but they are often used on larger scale projects like public buildings and retail developments to help the developers to meet environmental and bio-diversity targets and encourage the preservation of native flora and fauna.

7.64 Solar (Control) Glass

Solar glass manages solar heat radiation by three mechanisms: reflectance – the proportion of solar radiation reflected back into the atmosphere absorptance, absorptance – the proportion of solar radiation absorbed by the glass, and transmittance – the solar radiation transmitted directly through the glass into the indoor environment.

The Solar Heat Gain Coefficient (SHGC), which measures a window's ability to transmit solar energy into a room, is expressed in value from 0 to 1. The SHGC is commonly referred to as the g-value, or solar factor, the lower a window's g-value, the greater its insulation against solar heat build-up. Modern solar glass is an integral part of a buildings environmental control, reducing energy use and running costs and the need for air conditioning, in some cases eliminating it completely.

Solar glass can also be utilised in combination with double or triple insulating glass (IGU) and is typically employed in many facets of modern building, especially where solar heat gain is likely to be a factor. Installations can range from large façades, atria and conservatories to pedestrian walkways often using solar self-cleaning glass that works by using a combination of UV light from the sun and rain to break down and wash away dirt.

Solar glass is a highly practical modern solution to controlling the building in relation to its geographic location and the ambient climate. In temperate climates it can balance solar control with a high level of natural light and in hot climates reducing solar glare and heat gain. In cold climates solar glass prevents heat from escaping from the building whilst still allowing solar heat to enter reducing the need for heating.

7.7 Thermal Mass

The fluctuation of temperatures within a building can be an issue as it involves the use of air conditioning or the heating system. In the 1960s, scientists started to develop and experiment PCMs (phase-change materials) which have for advantage to store and release the heat when needed saving between 50%-70 % the energy consumption in a building.

Various building products exist but the most convenient material when undertaking a refurbishment is PCM ceiling tiles, which are suitable for use in the UK. An assessment of the most suitable way to use the PCM combined with the different type of air conditioning (displacement ventilation, overhead air and overhead air ducted return) was carried out. As a key result, the utilization of thermal mass is mostly efficient with the displacement ventilation due to the long lasting storage of the heat.

Useful Contacts

Part L 2013 Building Regulations
http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/approved

Phase Change Materials
http://www.pcmproducts.net

8 - Water Management Solutions

"Water and air, the two essential fluids on which all life depends, have become global garbage cans."

Jacques Cousteau
(Undersea Explorer and Environmentalist)

8.1 Water is Life

Figure 11: Hydro Power Plant

Source: © Pilens | Dreamstime.com - Small Scale Hydro Power Plant Photo

Access to water, the preservation and management of fresh water is one of the pressing global issues of the 21st century. As our global population grows and becomes wealthier, so the needs of industry, mining and agriculture grow, and the demand for water is increasing exponentially.

In parallel, water availability and quality are also under stress from climate change and deforestation. Scarcity and increasing costs make is imperative that we find better ways to manage fresh water resources, servicing the needs now and preserving stocks for the future. The treatment of water and re-use and saving by industry can make a major significant contribution to water security.

8.2 The Use of Water Saving Technologies – Water Recycling

Water reuse systems that collect waste water, treat and re-use it for other purposes on site are becoming more popular with businesses both as a method of securing their water requirements and cutting water disposal costs.

Captured and re-cycled water includes rainwater, process waste water and grey water. Typical systems have three stages: primary – removing suspended solids; secondary – biological treatment processes including possible aeration or anaerobic treatment and tertiary – usually involving a membrane technology that can filter out particles to a high level of purification.

Modern re-use systems can recover up to 99% of water but a more normal figure is around 70%. After going through the 4 stage process, the treated water is of very high quality and can then be used for almost any application including feeding water back in processes, flushing toilets etc.

8.3 Capital Allowances for Water Efficient Plant & Machinery

Enhanced Capital Allowance (ECA) schemes for energy-saving and environmentally beneficial (water efficient) technologies affects businesses purchasing designated plant and machinery which uses energy efficiently, reduces water use or improves water quality.[23]

Currently, capital expenditure by business on plant and machinery normally qualifies for tax relief by way of capital allowances. Once businesses have fully used their Annual Investment Allowance (AIA), which for the period 1 January 2013 to 31 December 2014 is £250,000, plant and machinery allowances are available at the 18% main rate and the 8% special rate.

[23] 2014- HM Government - Enhanced capital allowances schemes for energy-saving and environmentally beneficial (water efficient) technologies

It is intended that secondary legislation will amend the list of technologies that qualify for the energy-saving scheme to include two new technologies on the Water Technology List (WTL): Active chilled beams and desiccant air dryers with energy saving controls. The qualifying criteria for twelve current technologies will also be revised.

8.4 Qualification on the WTL

The ECA scheme offers a 100% first-year allowance for investments in certain water efficient plant and machinery. It means you can deduct 100% of the cost of qualifying plant and machinery against your taxable profits in the year of installation. The following technology areas are now included on the WTL for the ECA scheme:[24]

- Cleaning-in-place equipment: monitoring and control equipment, and spray devices
- Efficient showers: aerated showerheads, auto shut-off showers, flow regulators, low-flow showerheads and thermostatic controlled showers
- Efficient taps: automatic shut-off taps, electronic taps, low-flow screw-down or lever taps and spray taps
- Efficient toilets: low-flush toilets, retrofit WC flushing devices and urinal controls
- Efficient washing machines: efficient commercial and industrial washing machines

[24] HMRC - First Year Capital Allowances for Water Efficient Technologies

- Flow controllers: control and flow-limiting devices

- Greywater recovery and reuse equipment

- Leakage detection equipment: data loggers, pressure-reducing valve controllers, remote meter-reading and leak-warning devices

- Meters and monitoring equipment: flow meters and water management software

- Rainwater harvesting equipment: monitoring and control equipment, rainwater filtration equipment and rainwater storage vessels

- Small-scale slurry and sludge dewatering equipment: belt press, centrifuge and filter press equipment

- Vehicle-wash water reclaim units: partial or full reclaim systems

- Water efficient industrial cleaning equipment: scrubber/driers (walk-behind and ride-on machines) and steam cleaners
- Water management equipment for mechanical seals: seal water recycling units, internal flow regulators and monitoring and control units

- Water reuse systems on the WTL have two sub-sections:
    1. efficient membrane filtration equipment
    2. waste water recovery and reuse

Due to their bespoke nature, these technologies are both eligible for ECAs via a certification scheme for each individually installed system, rather than the standard product list used for other technologies on the WTL.

Water reuse involves reusing treated waste water from one process for a different purpose. Water reuse technology reduces the demand on drinkable sources of freshwater and reduces the volume of waste water discharged to the sewer.

Water reuse can be an economical way to reduce your costs.
The business sectors that can benefit most from using water reuse systems include the following industries:

- Food and drink
- Printing
- Chemicals
- Construction
- Electronics
- Metal finishing

If you are installing a water reuse system, you should ask your manufacturer or supplier to ensure that the design meets the eligibility criteria, as you must provide supporting evidence for this to Defra.

It is the responsibility of the business installing the water reuse system to apply to have it certified as eligible for an ECA, and Defra will award the business a 'Certificate of Environmental Benefit'. This certificate verifies that the design of that water reuse system meets the water-efficient criteria.

8.5 Water Labelling Scheme

The Water Labelling Scheme enables users to compare hundreds of products that meet the standards of the industry for water efficiency. It is typically aimed at professionals supplying installations for bathrooms and kitchens but is useful in understanding the range of rated products now available.

Useful Contacts

Gov.UK - Enhanced Capital Allowances for energy saving & water efficient technologies
www.gov.uk/government/publications/enhanced-capital-allowances-schemes-for-energy-saving-and-water-efficient-technologies

HMRC Capital Allowances Water
www.hmrc.gov.uk/capital-allowances/fya/water.htm#3

9 – How to Become a Carbon Star

This chapter takes a look at how your business can implement a lower energy and reduced CO_2 emissions strategy and what government and other agency support and finance is available to help make this happen.

"We live not, in reality, on the summit of a solid earth but at the bottom of an ocean of air."

Thales of Miletus (c.625-545 BC)

9.1 A Good Businesses is a Sustainable Business

Every entrepreneur founds his or her business believing it can last and grow. Whether the aim is to create a lifestyle company that provides a good living for the founders' and their families throughout their lifetimes or to build the next global giant, sustainability is a prime consideration. In today's world strategic business planning must go beyond mere return on investment (ROI) or profit and take account of where and how that business fits a modern and increasingly global society.

What improvements to its carbon footprint a company can achieve, and how flexible it is to change, will depend to a large extent on the type of business, scale and current financial position.

Clearly a company operating manufacturing plant, logistics and with a larger scale workforce faces different challenges and opportunities from an organisation that is office based; possibly with a number of people taking the option to work some of the time from home.

9.2 Finding the Resources

Every business however, regardless of size, wants to reduce its costs as in an ever more competitive market, because this can mean the difference between profit and loss.

Multi-nationals with offices in different geographies are likely to have a set of criteria of their own for achieving carbon savings and reducing costs and these may be governed by a global policy, country by country practices, rules and tariffs of where they are registered.

Their decision process will depend on whether they are a UK company or foreign-based but with a UK presence. As new legislation, Mandatory Carbon Reporting (MCR) governing UK Publicly Listed Companies is now coming into force, and those registered in the UK have to comply. This factor may well end-up being as much a driver for changes as cost savings or new revenue opportunities.

For smaller companies, the drivers are different, and change may be more difficult as capital is tight, and it can be challenging to find support for budgets to make improvements to buildings or invest in new plant that reduce carbon that may take as long as 5-10 years to show a return.

Regardless of the size of business or industry, to support the drive for resources that can impact positively on its carbon footprint, it is important to know where external support like grants, tax rebates and tariffs are available that can help stretch resources further.

9.3 Mandatory Carbon Reporting (MCR)

MCR is now in place for all London Stock Exchange Registered Companies but currently non-UK registered companies, companies listed on AIM and privately owned companies are excluded. Reporting covers:

- Emissions: material greenhouse gas emissions in CO_2 equivalent (all 6 Kyoto gases)

- Emission sources: scope 1 (direct) and scope 2 (indirect emissions from purchased electricity, heat or steam)

- Organisation boundary: to be defined by company but likely to be based on a financial control or an equity share approach; to be consistent with the financial report it will include global operations

The requirement came into effect in April 2013 and the first reporting requirement was in the Directors Annual Report for 2013/14.

9.4 Enhanced Capital Allowances

The Enhanced Capital Allowances (ECA) scheme allows businesses to write-off 100% of their investment in energy saving technologies that are listed in the Energy Technology Criteria List (ETL) against the taxable profits of the period during which they make the investment. ECAs are claimed in the same way as other capital allowances on the Corporation Tax Return for companies and the Income Tax Return for individuals and partnerships.

One of the qualifying technologies is good quality combined heat and power (CHP). In order to qualify for ECAs, a CHP plant must be certificated under the CHPQA programme and have a Secretary of State (SoS) Certificate of Energy Efficiency.

9.5 Business Rating Exemption

Business Rating Exemption applies to specified plant and machinery contained within CHP Schemes that are fully or partially certified as "Good Quality CHP" under the CHPQA programme and have obtained a SoS Exemption Certificate.

9.6 Energy Performance Contracting (ESCO)

ESCOs have been operating within the energy sector for many years and recognise the challenges that organizations face and the need for change. Typically they develop, install and arrange financing for projects designed to improve the energy efficiency and maintenance costs for facilities over a fixed period of years.

With the technology, expertise and proven solutions to help develop a strategy outlining the most effective path to improvement, an ESCO provides a comprehensive view of a building's carbon footprint. It will identify the areas where improvements can be made and enable the implementation of practical, engineered solutions to reduce energy consumption and carbon emissions.

Working with an EPC overcomes the need for upfront capital investment, and it guarantees future savings on energy and uses these to determine the customer's repayments and finance for practical, engineered plant improvements. Most projects will include maintenance of equipment over the lifetime of the contract with the customer benefiting from reduced energy and maintenance costs.

Using an ESCO is an innovative way of bringing about change whilst reducing risk and often overcoming a lack of in-house technical skills, resources and budget. The benefits are immediate, including reduced costs, improved building comfort and legislative compliance. Qualifying technologies include Solar thermal (which is different from the solar PV), micro-CHP, biomass boilers, air source heat pump, and biomass heating.

9.7 Renewable Heat Incentive (RHI)

In March 2011, the UK Government announced the details of their RHI. RHIs are annual subsidy payments over 20 years designed to provide financial support that encourages individuals, communities and businesses to switch from using fossil fuel for heating, to renewable such as wood fuel.

If heat and hot water are both being generated from pumps, solar thermal, biomass or bio-methane boilers, the subsidy can be paid at up to 8.5p/kWh, that the government claimed provides a return of 12% per annum. Industry estimates are somewhat lower at 6%-9% but even at that rate will provide an ROI within 5-10 years depending on the project.

RHI for Business:

The RHI helps businesses, the public sector and non-profit organisations meet the cost of installing renewable heat technologies.

To qualify for RHI, equipment must use liquid or steam to deliver the heat for space or water, or for carrying out a process where the heat is used within a building. The types of heating covered by the scheme are:

- Solid biomass - including solid biomass contained in municipal solid waste these must only be able to burn biomass
- Ground-source or water-source heat pumps with a 'coefficient of performance' (COP) at least 2.9
- Deep geothermal

- Solar thermal collectors – water heating panels must be 'flat plate' or 'evacuated tube'

- Biomethane injection and biogas combustion (except from landfill gas).

- Energy from waste

- Biogas – below 200 kWth

The following technologies come under the scheme, but are only eligible if they were commissioned from the 4th December 2013:

- Combined heat and power (CHP) systems – heat is generated from biogas, geothermal, solid biomass or waste

- Air to Water Heat Pumps

- Biogas – 200 kWth and above

To be eligible for RHI equipment must be new, have a specified capacity, and public grant funding must not be used to buy or install it. Additionally the equipment and installer must have Microgeneration Certification Scheme (MCS) or equivalent certification.

RHI cannot be applied to equipment used to heat a single home (though a combination of homes sharing a heating installation might be eligible e.g. a block of flats) how RHI was also introduced in two phases for domestic customers:

Phase 1 —– Non-domestic RHI Scheme

The phase 1 non-domestic RHI scheme supports and offers financial incentives for renewable heat installations in the commercial, business, industry, public sector and not-for-profit sectors. The eligibility criterion has undergone further revisions, and these were published on 28th May 2014. Details of these are available on Ofgem's website, and the contact details can be found in the "Useful Contacts" section at the end of this chapter.

Phase 2 – Domestic RHI Scheme

DECC announced on 20th September 2012 their consultation on the RHI - domestic phase 2. This consultation is a proposal and therefore details may change before policy is announced and laid before parliament. There is a sliding scale of tariffs proposed for Phase 2 that will be dependent on the fuel source.

9.8 The Green Deal

Households were able to start registering to have their home assessed under the Green Deal the Government's initiative to transform Britain's homes in October 2012.

The new initiative launched in January 2013 applies to both the domestic and non-domestic sector enabling the financing of energy efficiency improvements such as insulation or a new heating system. The Government claims that up to eight million households could benefit from solid wall insulation and four million households from cavity insulation.

Some or all of qualifying Green Deal work is then paid for over time through the electricity bill relevant to that property, the concept being that the savings on energy bills will cover the additional cost. Green Deal payments remain the obligation of the tenant or property owner, so when someone moves the surcharge continues to be applied to the new occupier's electricity bills

There are 45 types of qualifying improvements that will help people warm their homes better, and the Green Deal is an excellent opportunity for Housing Associations to retrofit their properties to make them more energy efficient.

Qualifying energy efficiency improvements can be made up to a maximum of £10,000 with no upfront costs but a small surcharge added to the tenant' electricity bill to payback for the Green Deal over a given period. The primary requirement is that the surcharge must not exceed the expected energy savings achieved by carrying out the improvements.

The Green Deal Scheme has received increased industry support since it was revealed that interest rates on loans will be less than 7%. The interest rate affects the amount of work that can be done under the scheme's Golden Rule that the combined cost of energy efficiency measure and finance must not exceed the savings on the customer's energy bill.

With an estimated 38% of greenhouse gas emissions coming directly from leaky buildings, the Green Deal has huge potential to improve the quality of wellbeing for building occupants whilst in parallel making a significant contribution to emissions reduction.

9.9 Feed-in Tariffs (FITs)

Encouraging the installation and use of alternative power generation and heat sources are an important part of the Government's strategy.

The FIT is for small scale (up to 5 MW power) producers of renewable production of excess electricity exported to the grid. The level of the tariff depends on the type and size of technology being used and when it was installed. The tariff pays for every kWh of electricity generated and is guaranteed for 20-25 years.

The UK Government believes that solar PV has the potential to form a significant part of the renewable energy generation mix with smaller scale (less than 50 kW) solar PV installations, supported through the FITs scheme, likely to remain the main driver for the growth in solar PV capacity.

9.10 Carbon Trust Loans

The Carbon Trust is an independent, not-for-profit company setup by the UK Government to work with business and the public sector to cut carbon emissions through practical advice and support.

The Trust provides interest free Energy-Efficiency Loans on an unsecured basis, typically for £5,000-£200,000. Repayments are offered over 12-48 months and designed to reduce carbon emissions by enabling businesses to overcome the capital barrier of purchasing energy saving equipment.

With increasing utility prices, the monthly energy cost saved from installing new equipment will often exceed the loan repayment. In most cases, projects can be funded from energy savings alone as the loans are interest free.

Eligible Businesses in England & Scotland

Eligible Businesses in England & Scotland are private sector small and medium-sized enterprises (SMEs) with a trading history of at least 12 months and an acceptable credit rating. The scheme also recognises charities and societies to be SMEs.

A business is designated to be an SME if:

- It has fewer than 250 full-time equivalent employees, or
- It has less than €50 million turnover (approx. £35 million) or less than €43 million in assets (approx. £30 million)

And:

- Is less than 25% is owned by another business

Eligible Businesses Wales & Northern Ireland

Eligible Businesses Wales & Northern Ireland private sector businesses of any size may apply, as long as they have a trading history of at least 12 months and an acceptable credit rating.

State Aid Restrictions

Companies operating in primary agricultural, fisheries and aquaculture, transport, coal or export-related activities are not eligible.

9.11 Making a Start

As discussed previously, the scale and ease of change depends on the type or organisation. Clearly a manufacturing company with factories and a potentially complex supply and distribution chain faces different challenges to a retailer, service orientated organisation or a property developer seeking solutions to build carbon neutral homes.

For many organisations, there are often obvious ways to make changes which can be as simple as tasks like proper maintenance and servicing of equipment e.g. air conditioning, or implementing a power optimisation programme or insulating a building.

New technologies can play a significant part, and in all areas there are major advances being made almost on a daily basis. Undoubtedly the replacement of old technologies with newer, cleaner, leaner versions can make a significant contribution to becoming a carbon neutral business.

For businesses making major changes that require capital expenditure they often require months or even years of planning. However other, often less obvious, are as much to do with changing human behaviour, company policies and practice as it is investing in replacement technologies.

9.12 Expert Energy Efficiency Audit

The approach to adopting new technologies and processes is not one solution in isolation, rather an overall view of how different areas can be addressed to complement each other, otherwise known as holistic thinking. For example, power and water are inextricably linked together and so are potential solutions like all building drinking water can have an effect on both energy use and water wastage.

To fully understand your best options for a low carbon future and to ensure you do not make expensive mistakes is to commission an expert assessor to complete a business audit.

Typically an audit will involve analysing all aspects of your building, existing technologies and processes and preparing a report on the ways you can reduce carbon emissions, where you can save energy and costs and where you can potentially create new revenue streams.

9.13 Typical Process for Implementing & Monitoring Improvements in Your Business

1: Choose and Contact a Qualified Energy Assessor

2: LED Lighting Feasibility Study

- Cost savings avg. £17,850 p.a.
- Carbon savings 110T p.a.
- Operational Expenditure (OpEx) cost reduction 76%
- Payback 1.65 years
- Grant funding availability advice

3: Air Conditioning Pre-inspection

- UK ACI Legislation Check (over 12kw)
    - EPBD compliance advice
- Obtain ACI quote

4: Energy Tariff Review

- Cost savings avg. £5,500p.a.
- OPEX cost reduction 11.5%
- Renewables tech review

5: PV Installation Advice

- Cost saving avg. £8,000 p.a.
- 12.5% carbon saving
- Income (FIT) avg. £20,000 p.a.
- 8.8 year payback period
- Grant funding availability advice

6: Measure and Target EPC/DEC

- EPC grade improvements (D to B)
- Carbon savings 140T p.a.
- Obtain EPC/DEC quote

9.14 The Impact on People

The route to successfully implementing a low carbon future involves or affects everyone in an organisation of business to some extent. At the high level, this may involve business and budget planning, and it will certainly include those responsible for the delivery of building services and office workers and how they behave in their daily tasks will affect the success of any programme.

Often even relatively simple actions can make a significant contribution to reducing emissions when multiplied across many people in their daily workplace. Therefore employee engagement is crucial to the on-going success of any project.

It is a good idea therefore to start consultations even before any refurbishment programme is implemented, seeking people's views on issues that can affect their working conditions, such as lighting. Also including employees in the decision making process will share the ownership with them as they are likely to respond more positively to any disruption and new processes.

Useful Contacts

Gov.UK - The Green Deal
www.gov.uk/government/collections/green-deal-quick-guides

Department of Energy and Climate Change - ECA Scheme
https://etl.decc.gov.uk

Carbon Trust - Mandatory Carbon Reporting
www.carbontrust.com/resources/guides/carbon-footprinting-and-reporting/mandatory-carbon-reporting

Ofgem - RHI
www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi

10 - The Journey Starts with One Small Step

"All of life is interrelated. We are all caught in an inescapable network of mutuality, tied to a single garment of destiny. Whatever affects one directly affects all indirectly."

Martin Luther King Jr.

10.1 Author's Conclusion

My business involves advising companies and other organisations how they can improve their carbon footprint, water usage and energy consumption and the actions they can take to reduce the costs of an existing operation or how to develop a new and more efficient one.

In working with our clients, I have to come to understand the pressures that modern businesses face including the challenges of globalisation and increasing legislation. However, I have also come to believe, that with forethought and planning, there is probably not a single business that cannot benefit itself and the environment from reducing its carbon footprint and energy consumption.

Even the smallest of changes multiplied many thousands of times will have a significant impact. In business, what is needed is continuous monitoring. In concrete terms this means capturing good quality data, as this allows for good strategic business decisions from key KPIs. It is necessary to measure building energy performance and business profits, and seek correlations between the two.

Business owners/decision makers are by nature and necessity pragmatic. We should not seek to change this characteristic. However pragmatism leads to at biases that impact strategic decision making.

We like to make decisions on facts - nothing wrong there. Our business is low carbon design engineering where we use 'facts' day in and day out for making technical decisions. But in business there are some instances where we cannot adopt this approach - we cannot wait for all the facts to be in before reaching strategic decisions. Why? Because others will have moved before us, and the game will be over. As military strategists tell us, most battles in history are decided before the first shot is fired. The side that has correctly chosen where and how to fight, wins. In the context of this book's title, we should use theory to assist our strategic decision making. In other words, to make strategic decisions, we need to be guided by a 'theory' that allows us to act before all the facts are in. Hopefully this book assists with setting out theories. Sometimes in business we cannot wait for all the facts.

Also what is needed is the will to learn, and when the benefits become apparent, to invest a little in the future.

Alan King

“Don't go around saying the world owes you a living. The world owes you nothing, it was here first.”

Mark Twain

Glossary of Technical Terms

Term	Definition	Alias
ACI	The ACI is an assessment that is designed to improve efficiency and reduce electricity consumption, operating costs and carbon emissions of air conditioning systems in buildings.	Air Conditioning Inspection, Air con inspection, ACI assessment, ACI inspection, ACI survey
BMS	A BMS is used in buildings to create a central computer controlled method of controlling, monitoring and optimising facilities such as heating, air conditioning, lighting and security. These systems allow easier operation of facilities and reduce energy waste as facilities are only used when they needed.	Building Management System, BEMS, IBMS
CEA	A CEA is accredited to carry out the inspection and compilation of the commercial Energy Performance Certificate (EPC).	Commercial Energy Assessor, NDEA
DEA	A DEA is accredited to carry out the inspection and compilation of the domestic Energy Performance Certificate (EPC).	Domestic Energy Assessor
DEC	A DEC is a certificate that shows the actual energy usage of a public building (Operation Rating) on a scale of A-G.	Display Energy Certificate

EPBD	The EPBD is the Directive 2002/91/EC (EPBD, 2003) of the European Parliament and Council on energy efficiency of buildings. The Directive came into force on the 4th January 2003 and had to be implemented by the EU Member States at the latest on the 4th January 2006.	European Performance of Buildings Directive
EPC	An EPC is a certificate that tells you how energy efficient a property is on a scale of A-G.	Energy Performance Certificate, Domestic EPC, Commercial EPC
FM	FM is the integration of multiple disciplines necessary for the ensuring functionality of the land, buildings, infrastructure, furniture, equipment, and fixtures of a company necessary for the operations of the business.	Facilities Management
HIP	The HIP is a collection of documents relating to a property, which, under the law of England and Wales as of June 2007, must be provided when the property is offered for sale.	Home Information Pack
IB	An IB provides a sustainable, responsive, effective and supportive environment within which individuals and organisations can achieve.	Intelligent Building, Smart Building, Intelligent and Green Building

IFE	Founded in 1918, the IFE is a non-profit making professional body. Licensed by the Engineering Council (UK), the IFE upholds professional standards within all public and private fire sectors.	Institute of Fire Engineers
OCEPC	An OCEPC is a certificate that tells you how energy efficient a new build domestic property is on a scale of A-G. The property cannot be signed off by building control without this document.	On Construction Energy Performance Certificate, New-build EPC, On Construction EPC, Completion EPC
Part L	Conservation of Fuel and Power – Building Regulations. Part L sets the thermal efficiency standards that buildings must comply with. All windows must meet the standards set out in Part L.	Part L – Building Regulations
PEA	A PEA is a predicted energy efficiency assessment that is simply a way of providing information about energy performance for homes that have not been built yet (off-plan sales).	Predicted Energy Assessment
PIQ	A PIQ is a document that forms part of the HIP that states details of the property pre-sales information, including the home's council tax band, parking arrangements, utilities	Property Information Questionnaire

	and structural alterations by the vendor.	
SAP	A SAP is a calculation method that is contained within UK Part L Building Regulations for dwellings. The SAP calculation provides an assessment of a dwelling's energy and carbon performance.	Standard Assessment Procedure
SBEM	SBEM is a software tool developed by the Building Research Establishment (BRE) that provides an analysis of the energy consumption of buildings other than dwellings, used in support of the National Calculation Methodology (NCM) and the Energy Performance of Buildings Directive (EPBD).	Simplified Building Energy

HOW REDUCING YOUR CO2 EMISSIONS COULD INCREASE YOUR BOTTOM LINE

This book is designed to provide a practical guide to the options businesses have to enable them to reduce emissions and save energy, in particular the contribution that can be made by more proactive management of buildings and equipment.

ABOUT THE AUTHOR

Alan King (Msc BEng (Hons), MAPM, AMCIBSE, MIET, dipDEA, dipCSH) is the Founding Director of the Award Winning Low Carbon Building Solutions Company Syntegra Consulting Ltd. He has in excess of 15 years experience in Energy & Engineering Design Consultancy with technical & project management experience including blue chip companies, joint ventures, SME's, start-ups and emerging industries. Previous roles include: Head of Property Development for a boutique Super-Prime West-End Developer (development portfolio £80m GDV: projects with area values of <£3,500/sqft); Head of Solutions Development for the Systems Integration Division of the largest privately owned £500m M&E contractor in the UK, helping build the 4-man division from scratch to £8m with 35 staff. Alan graduated from Reading University in 2003 with an MSc in Intelligent Buildings, and Brunel University with a BEng (Hons) in Engineering Science and Technology. He is a previous board member for the International Intelligent Building Group and he presently sits on the executive board for Constructing Excellence – Berkshire.

Awards

- *Finalist for the Business Green Leaders awards 'Entrepreneur of the year' 2014*
- *Awarded strategic sponsorship under the Goldman Sachs 10k scheme 2013*
- *Finalist for Haines Watts Young entrepreneur award 2012*

- *Finalist for SECBE Young achiever award 2012*
- *Finalist for National CIBSE Young M&E Consultant 2004 Award*
- *Winner IMECHE James Clayton Post-Graduate 2002 Award*

He spends his spare time with his wife and two children; he also enjoys Rugby and playing the saxophone.

Syntegra Consulting is a recipient of the Business Green Awards 2014, Scoot Headline Awards 2014, Goldman Sacks 10K Business Strategic Sponsorship Programme Award 2013, Green Apple Awards for the Built Environment 2013, Smarta 100 Awards 2013, the London & South East BCO Award 2012, Thames Valley 250 'Company to Watch' 2011 & 2010 and awarded SEEDA funding via Thames Valley IGT 2010.

Syntegra Consulting had its inception in 2008 when Alan discovered a niche in the business market, which is the increasing legislative drive towards sustainability and green building. The success of Syntegra Consulting has allowed the business to fund and secure 1 acre of Peruvian rainforest. In addition, the business is a supporter of the Camino Verde Foundation, a US charity that strives to secure 100 acres of rainforest in the guarded forest of Tambopata and to plant 1000 Amazonian trees. As well as this, Syntegra Consulting has provided funding for a hospital in Malawi to install 25 kwp solar PV.

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In "How Reducing Our CO_2 Emissions Could Increase Your Bottom Line" Alan Wing-King – Managing Director and Founder of the multi-award winning international property company Syntegra Consulting – provides you with strategies and explains how you can save money in your business by decreasing your carbon emissions using current industry insight and carbon reduction strategies. The strategies are articulated in a succinct, practical and pragmatic manner, and your company will see the instant benefits of the strategies to provide solutions in creating a more efficient business.

This book is packed full of facts and empirical evidence, and each chapter has finance and carbon reduction at the forefront. The book takes you through each of the different types of sustainable energy technologies and explains their financial benefits and how these can be used in business. Business leaders, owners and senior decision makers will appreciate what this book has to offer. The market and economy are dynamic and constantly developing but one thing that will never change is the need for energy.

To save money in your business today and reduce your carbon footprint, this book contains everything you need to know – for the benefit of your business and the wider community it serves, now and into the future because the decisions you make today are critical.