



**HÁSKÓLINN Á BIFRÖST**  
BIFRÖST UNIVERSITY

## **Solar Panels as an option for households in the UK**

Final Assignment to a bachelor degree in Business Administration

Autumn 2011

Author: Heiðrún Á. Guðmundsdóttir

Supervisor: Auður H. Ingólfssdóttir

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The final assignment has been evaluated according to the regulations and demands of Bifröst University and has received the final grade:

## Abstract

Households are encouraged to invest in solar panels with schemes that the government has in place as part their battle to cut emission and tackle climate change.

The objective of this research project was to find out if investing in solar panels is an realistic option for household in the UK.

Methodology used was in the form of a 4 different types of research that aimed to study all aspects of different factors contributing to the final decisions.

First step was to gather secondary data to get the wider picture. Second step was to do a primary research in form of focus groups to get information about householder's views and feelings. Third step was a primary research in the form of an interview with an owner of a solar company and the forth was a focus group.

Because human's consumption of energy over the years has caused environmental damage that is affecting society as whole, the decision about energy options should not only be based on profitability. The conclusion is therefore based on three factors which are society, environment and profitability.

The results show that investing in solar panels is a realistic option for households regarding all these factors. However, there are limitations as this option is not available for every household in the UK.

## **Acknowledgements**

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I, the undersigned, have done this project on my own and fully according to the regulations and demands of Bifröst University regarding work of final assignments in undergraduate studies.

Hastings, 13 December 2011

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Heiðrún Ásta Guðmundsdóttir

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## 1.Introduction

The Solar industry is very new and currently being build up mainly by government subsidies in the aim of meeting their targets in cutting emission and tackling climate change. Households are encouraged to invest in solar panels but not many choose to do so. The researcher found this interesting and the aimed to find out if investing in solar panels is a realistic option for households.

### 1.1Research question and objective

The objective of this project was to research how realistic and beneficial solar panel instalment is as an option for households in the UK.

A research question was set out in the beginning in accordance with the objective and aims of this project.

*Solar panels, an realistic option for households in the UK?*

The goal was to answer this question to the best ability by looking into all aspects that can influence the final conclusion.

To gain the best insight and information this was done in four sections of a research process.

1. Gathering of secondary data which provides information relevant to the research question and gives the wider picture that will then be narrowed down to the exact subject of the project
2. Primary research in the form of focus groups which aimed to give information about householder's views and feelings.
3. Primary research in the form of an interview with the aim to gather information about solar panels including the cost and benefit.
4. Primary research in the form of a case study aimed to get into views and experience of someone who opted for the option of solar panels.

### 1.2Methodology

Primary and secondary data was collected and analysed.

Secondary data was collected using academic journals, report publications and the internet. Using a collection of secondary data gives a wider choice of information and collective ideas making it easier to find objective findings. (Bryman, 2008) Great care was taken to ensure that all secondary data used was valid and high quality.



Primary data was collected by performing three different types of researches, using both qualitative and quantitative research methods.

Initially two focus groups were created to highlight views and attitudes of householders.

Focus group is a form of qualitative research where a group interview is used. There are several participants in addition to the moderator. The emphasis is usually on a fairly tightly defined topic and the accent is upon interaction within the group. The aim is to gather information about people's views and feelings about the defined topic. (Bryman, 2008)

The moderator leads the conversations and aims to get people to talk at length and in detail about the subject in hand. The idea behind focus groups is that a response for one person will become a stimulus for others and thereby lead to a interplay of responses that give more information than single interviews. (McDaniel & Gates, 2008)

Results from the focus group were used to form relevant questions. In order to get these questions answered and to get some insight into the solar panel business, Qualitative research in the form of a semi structured interview was performed with an owner of a small solar company.

When doing a semi structured interview, the researcher prepares questions or fairly specific topics to be covered. This is often referred to as an interview guide, but the interviewee has a great deal of leeway in how to reply. Questions that are not included in the guide may be asked as the interviewer picks up on things said interviewees, and other questions may not follow on exactly in the way outlined in the schedule. (Bryman, 2008)

Another element of the research for this project was in the form of a case study on a consumer who opted for solar panels. Case study is a research design that entails the detailed and intensive analyses of a single case. This study took place on what might be called as an exemplifying case, meaning that it was chosen because researcher believed it would provide suitable information in context with the research question. Because most case studies require intensive and detailed examinations, combined qualitative and quantitative research methods are required. (Bryman, 2008)

## 2. Sustainable development and environmental issues

### 2.1 Sustainable development and public awareness

Environmental awareness can be tracked as far back as to the end of the eighteenth century. At that time the study of environmental issues did not yet exist but the foundation for the discipline were being laid.

In 1798 the book, *An essay of the Principle of Population; or the view of its Past and Present Effects on Human Happiness: with an inquiry into prospects respecting the future removal or mitigation of the evils which it occasions*, was published in London. The author was T.R. Malthus and the book is alarming as it makes clear that natural resources are finite and that population growth is an important factor in the use of these resources. (Nelissen, Van Der Straaten, & Klinkers, 1997)

The economics of welfare by A.C. Pigou was published in 1920. Pigou writes about national dividend (GNP) and the meaning of that definition for the measurement of welfare. He comes up with the concept of negative external effects that production has on the environment, and argues that the authorities should internalize those negative externalities by putting a special pollution tax on the producers. (Nelissen, Van Der Straaten, & Klinkers, 1997)

Economist E.G. Mishan writes along the same lines in his book *The Cost of Economic Growth*, which was published in 1967. Mishan criticises the concept of economic growth as it is based on easily measured economic parameters such as for example the level of employment, public debt and the exchange rate. Mishan argued that it is often difficult or even impossible to measure the environmental cost but agrees with Pigou that the cost price of product does not really reflect the total price because environmental costs of producing the product should be included. (Nelissen, Van Der Straaten, & Klinkers, 1997)

#### *The sixties*

Even though environmental effects have been a matter of concern for many centuries, the first significant awareness happened in the 1960s, and since then there has been growing acknowledgement that human activities do not only alter local environmental quality but may also destabilise global systems. (Selman, 2000)

In 1962 Rachel Carlson published the book *Silent Spring*, where she describes the effects of exposure resulting from the indiscriminate use of chemicals and the affect they have on the environment. The book attracted a lot of attention and was a wakeup call for many, and even led to a foundation of a Senate Committee for Environmental Affairs by John F. Kennedy in the US. (Nelissen, Van Der Straaten, & Klinkers, 1997)

### *The seventies*

In the 1970s politicians became active in the field of environmental problems and many national governments started to work on environmental policies. This was owing to the growing awareness of environmental problems in society. (Nelissen, Van Der Straaten, & Klinkers, 1997)

After the publishing of *Silent Spring*, environmental issues had become a lot more high profile, and in 1972 a global environmental movement finally emerged. That was with the first United Nations Conference on the Human Environment in Stockholm which was an event that marked the beginning of an era of considerable environmental activity on global, national and local levels. (Hunter & Gibbs, 2007) Up until then environmental problems had mainly been seen as regional or national problems, but in the United Nations Conference on the Human Environment, international environmental problems could be discussed which resulted in declaration. The declaration set principles to inspire and guide people in the preservation and enhancement of the human environment. (United Nations Environment Programme)

One of the main issues brought up in the conference was air pollution. Sweden argued that emissions had to be reduced because their fishing lakes were being damaged by industrial emission of Poland, Germany, England and the Netherlands. These countries were not prepared to take responsibility for the damage without proof, but agreed that international research should be done to provide more insight to these problems. In the first results which were published by the OECD in 1977 it became very clear that transboundary air pollution was very common. The first European policy for protecting clean air followed where the necessity of reducing emission was agreed, but the participating nations were not able to agree on specific measures until 1985. (Nelissen, Van Der Straaten, & Klinkers, 1997)

Blueprint for survival was published that same year in the British magazine *The Ecologist*. The article was drawn on data provided by a research team at the Massachusetts Institute of Technology and had the view that continuous growth would lead to break down of society and the irreversible disruption of the life-support systems on this planet. As a solution, the Blueprint for Survival proposed a “steady state economy” featuring for example resource self-sufficiency, energy conservation and resource recycling. The outcome would be that people would show more interest in the quality of life rather than increasing the number of their material possessions. (Reid, 1995)

Also in 1972 Meadows published the book *Limits to Growth*, which since has been very influential. The book is based on models that combine available information with future predictions using new information-processing tools such as system analysis and modern computer. (Nelissen, Van Der Straaten, & Klinkers, 1997) This was done by applying emergent possibilities of computer simulation to alternative trajectories for global population, pollution and resource use. (Selman, 2000) The main conclusions of the book are that there are limits to economic growth, and if current growth remains unchanged then the limits will be reached within the next hundred years. The book also says that it is possible to alter these growth trends and to establish economic stability and by implementing policies that aim to reach sustainable development. These conclusions were met with a large amount of criticism. *Limits to Growth* highlighted the perspective that the possibilities of the ecosystem in the production and consumption process is limited, which found its way into many western policies of that time. (Nelissen, Van Der Straaten, & Klinkers, 1997)

*Towards a Steady-State Economy* was published in 1973. This is a collection of articles by various influential authors and edited by Herman Daly. The authors try to develop new ideas and approaches which are relevant to the newfound environmental issues and are all convinced that a limit should be set to further expansion of economic development. (Nelissen, Van Der Straaten, & Klinkers, 1997)

### *The Eighties*

Awareness for environmental issues had increased considerably in the eighties and could no longer be ignored, so in many western countries environmental issues were permanently placed on the political and policy agenda. (Hunter & Gibbs, 2007)

In 1980 the Global 2000 Report to the President was published in the US, which was a report of a study that showed that the earth was in critical condition and action was needed immediately. The report convinced the US government and congress of the seriousness of environmental issues, as well as raising the awareness of the American public. (Nelissen, Van Der Straaten, & Klinkers, 1997)

One of the most influential studies of the eighties is Our Common Future, a report that was drawn up in 1987 and published by the UN World Commission on Environment and Development. It is sometimes called “The Brundland report” the Norwegian Prime Minister ,Gro Harlem Brundtland, was the chair of the commission. The document uses a definition of the concept “sustainable development” which proved to be very influential and many countries adopted these views when making their environmental policies. The definition is; “to ensure that development meets the needs of the present without compromising the ability of future generations to meet their own needs” The meaning of the concept appealed to everyone and has been thought to play a big role in making people more aware that the environment is not an isolated issue but has a relationship with developmental issues. (Nelissen, Van Der Straaten, & Klinkers, 1997)

### *The Nineties*

UN conference in environment and development was held in Rio from 3-14 of June 1992. The aim of the conference was to reaffirm the declaration from United Nations Conference on the Human Environment in Stockholm 1972. As a result of that conference a document was produced which is known as the Rio Declaration. The document consist of 27 principles intended to establish a new and equitable global partnership, work towards international agreements and guide future sustainable development globally by Recognizing the integral and interdependent nature of the Earth. (Rio-Declaration, 1992)

### *Recent developments*

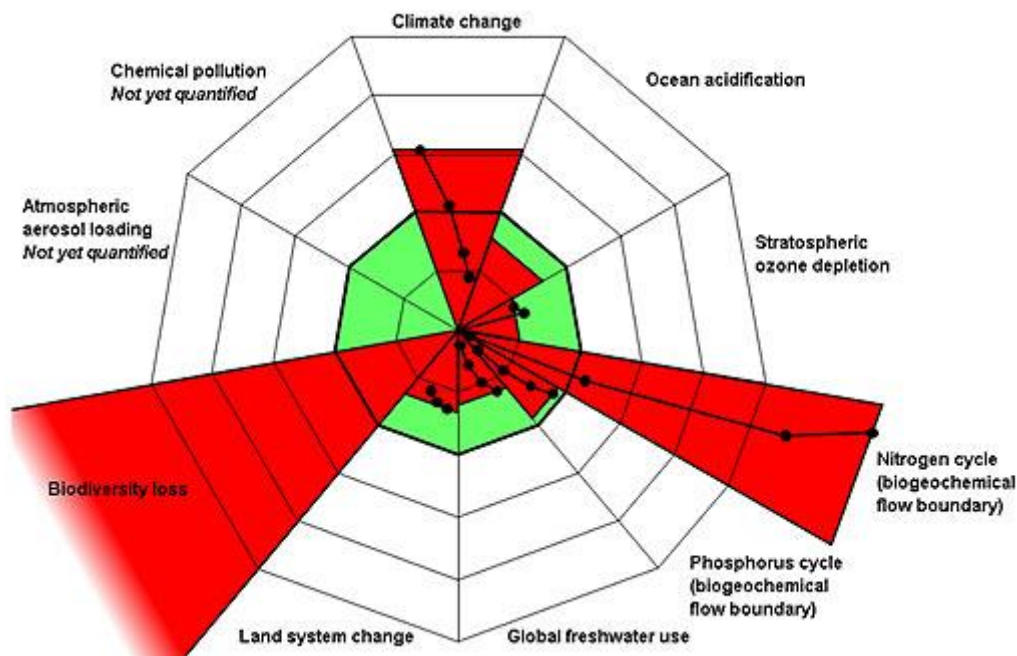
Ten years later, the World Summit of sustainable development was held in Johannesburg, South Africa. The Summit took place from 26 August to 4 September 2002 and brought together tens of thousands of participants, including heads of State and Government, national delegates and leaders from non-governmental organizations The aim was to focus the world's attention and direct action toward meeting difficult

challenges, including improving people's lives and conserving natural resources. (Johannesburg Summit 2002)

## 2.2 Planetary Boundaries

It has been proven that climate change is a global environmental threat that, amongst other threats that may lie ahead, needs to be dealt with. To offer humanity ways to deal with this a group of 28 internationally have attempted to identify global biophysical boundaries. These boundaries who are identifies on the base of scientific understanding of the Earth system, can define a safe planetary operating space that will allow humanity to continue to develop and thrive for generations to come. (Simonsen, 2009)

This new approach to human sustainability was published on the 14<sup>th</sup> of September 2009, under the lead of Johan Rockström, director of the Stockholm Resilience centre. The scientists warn that that transgressing one or more planetary boundaries may be deleterious or even catastrophic due to the risk of crossing thresholds that will trigger non-linear, abrupt environmental change within continental to planetary scale systems.



**Figure 1** Estimates of how the different control variables for seven planetary boundaries have changed from 1950 to present. The green shaded polygon represents the safe operating space. (The Stockholm Resilience Centre)

Nine planetary boundaries were identified and quantifications for seven of them were proposed. The nine boundaries identified were climate change, stratospheric ozone, land use change, freshwater use, biological diversity, ocean acidification, nitrogen and phosphorus inputs to the biosphere and oceans, aerosol loading and chemical pollution. The study estimates that three of these boundaries, the one for climate change, biodiversity and nitrogen input, may already have been transgressed by humanity. (The Stockholm Resilience Centre)

Climate change: Recent evidence suggests that this planetary boundary has already been transgressed and we have reached a point which the damage is almost certainly irreversible. The question is how long we can remain over this boundary before more major irreversible changes become unavoidable.

Ocean acidification: Around quarter of the CO<sub>2</sub> humanity produces is dissolved in the ocean where it forms carbonic acid that alters the oceans chemistry and decreases the pH of the surface water. Ocean acidification may have serious impacts ocean ecology and ecosystems, and if transgressed will cause ramifications for the whole planet.

The stratospheric ozone filters ultraviolet radiation from the sun and damage to this layer increases amounts of ultraviolet radiation will reach ground level causing damage to humans, terrestrial and marine biological systems.

Nitrogen and phosphorus inputs to the biosphere and oceans: Local to regional interference with the nitrogen cycle and phosphorus flows has induced abrupt shifts in and marine ecosystems.

Local and regional biodiversity changes can have pervasive effects on Earth System functioning and interact with several other planetary boundaries.

The freshwater cycle is strongly affected by climate change. Humans are now the dominant driving force determining the function and distribution of global freshwater systems and water is becoming increasingly scarce with about half a billion people being likely to the water stress category by 2050.

Land is converted to human use all over the planet and contributes to global environmental change with the risk of undermining human wellbeing and long term sustainability.

Aerosols influence the climate change and have adverse affect on human health at regional global scale.

Chemical pollution: Emissions of persistent toxic compounds such as metals, various organic compounds and radionuclide's, represent some of the key human-driven changes to the planetary environment. There are a number of examples of additive and synergic effects from these compounds which are are potentially irreversible Chemical pollution adversely affects human and ecosystem health. (The Pelican Web, 2011)

### 2.3Climate change

Consumption of energy, especially fossil fuels such as oil and coal, carries high costs to the environment. Mining for coal and drilling for oil and gas as well as distributing the resultant fuels to the point of use have the most obvious environmental effects. (Elliot, 1997) Mining activities release the greenhouse gas methane which contributes to an enhanced greenhouse effect and increases the risk of global warming. Mining can also affect land stability. The oil industry makes a significant contribution to water pollution which can have devastating effects on wildlife, inshore fisheries and tourist amenities. In 1991 the oil industry was responsible for 24 percent of all reported pollution incidents in England and Wales. (Huby, 1998)

It is however the use of these fuels the present the major problems as burning these fuels in for example power stations to generate electricity, or in homes to provide heat generates a range of harmful gases and other wastes. (Elliot, 1997)

When fossil fuels are burned to produce energy they release carbon dioxide, methane, black smoke, oxides of nitrogen and sulphur dioxide. These air pollutions have great negative impact on the environment. More importantly, the releases of greenhouse gases and that respect especially carbon dioxide have caused great global concern in the recent years as there is growing evident about the implication of this for global warming and subsequent climate change. (Huby, 1998)

The Earth atmosphere has been linked to a greenhouse. Solar radiation warms up the Earth's surface which reradiates energy outward a bit like radiation. The greenhouse gases absorb this radiation and prevent some of it from escaping, acting like the glass of a greenhouse to keep the heat in. (Townsend, 2008) In this case the greenhouse being the world could result in the whole world heating up.



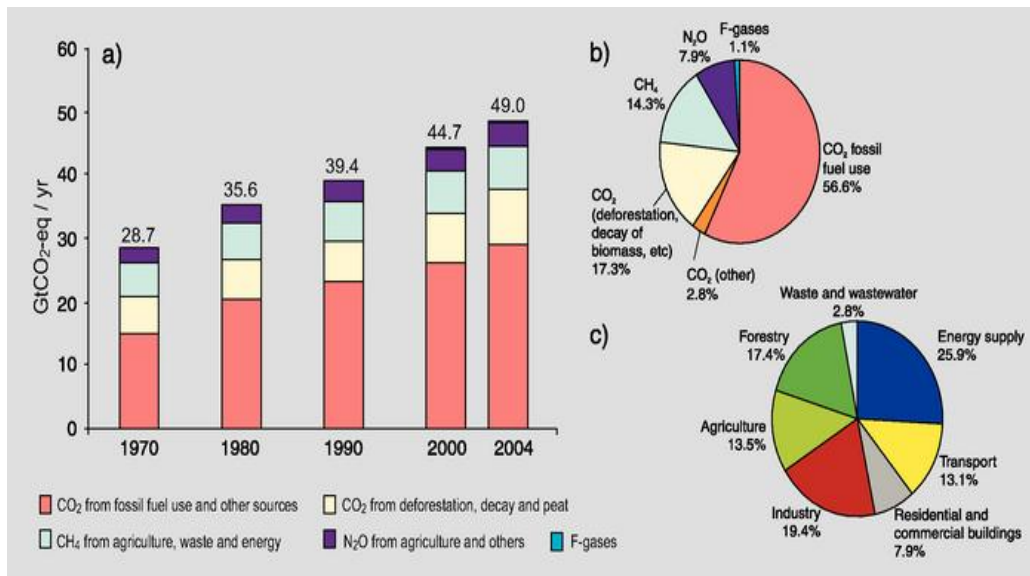
The results of global warming could be very severe. Icecaps could start melting which would cause sea levels to rise. Global warming could also cause extreme weather conditions as climate pattern would change. (Elliot, 1997)

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change that benefits from the work of thousands of scientists from all over the world. IPCC has the role of providing the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. (IPCC)

In their fourth assessment report called Climate change 2007; The Synthesis Report, IPCC has the following definition on climate change;

*“Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.” (2007, p. 8)*

Their conclusion of the report is that warming of the climate system is now “unequivocal,” based on observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. It also says that it is very likely that the observed increase in CH<sub>4</sub> concentration due to agriculture and fossil fuel use. (IPCC Synthesis Report, 2007)



**Figure 2 Development of emission levels from 1970 – 2004 (IPCC)**

It is a fact that the environment is constantly changing and often due to natural causes that human on earth have little control over. However, the changes in the environment caused by human action, often called anthropogenic, have increased considerably. Evidence show that present energy systems, based on fossil fuel and biomass burning, is probably the main source of environmental impact at all levels. (Goldemberg & Lucon, 2010)

## 2.4 Social cost and externalities

Adam Smith suggested that a market economy is efficient and demand and supply will always find its equilibrium in the competitive market, as if “by an invisible hand”. The consumer buys goods until his marginal cost equals the marginal benefit of the good to him. If society’s marginal cost of making a good does not equal marginal benefits from consuming that good a market failure exists. Externalities are a source of a market failure. (Begg, 2009). Externalities can be defined as unintentional side effects of production and consumption that affects a third party. (Turner, Pearce, Bateman, & Ian, 1994) Economists use the word to refer to the impacts of market activity that is not fully accounted for in the price of the product. Externalities can be either positive or negative, but in the case of environmental matters they are usually negative. (Huby, 1998) Pollution is seen as an external cost of production that is imposed on the whole society, because when people pollute the environment the cost is borne mainly by others. (Sloman, 2006) All environmental improvement usually comes at a cost,

whether it is a cost of cleaning up waste or a cost in terms a higher price a consumer has to pay for green products such as electricity from renewable sources. (Sloman, 2006)

From a consumers point of view the cost of energy can be analysed by both looking at how much they have to pay for it (private cost) and also how much is the environmental cost (social cost). Even though it has long been recognized that energy sources are significant contributors to environmental damage, until recently these external costs have not been taken into account in energy pricing. The attitude that the environment and its resources are free for everyone resulted in power companies passing these costs into society and no one wanting to take responsibility. (Hill, O'Keefe, & Snipe, 1995)

Economists can identify four different approaches to the environment and sustainability. At one extreme is the free market approach. That explains the attitude that individual property owners can do as they choose, and the environment and its resources are common assets that individuals can use for their own benefit. Sustainability is therefore only achieved because resource prices rise as they become scarce and environmental friendly choices are in consumer's private interests.

Next is the social efficiency approach, which is a less extreme version of the free market approach. Consumers with this view do look at the environmental cost as well and take some responsibility. Here social costs and benefit are taken into account, to the extent that they adversely affect human beings. The conservationist approach takes this responsibility a bit further by including the environment for its own sake. Such view sees the maintenance of the environment as an ethical constraint on human activity, and puts greater emphasis on the maintenance of ecosystems than the importance of material consumption and economic growth.

The strongest approach is the Gaia approach. Here the earth itself as well as its various natural species of animals and plants have moral rights. People should respect the rights of the environment to remain unharmed by human activity, as the planet does not belong to them. (Sloman, 2006)

Economists agree that a choice between these four approaches is essentially normative, and do not try to stand in judgement between them, but instead try to help to identify the optimum decision within a given set of values. That can help in trying to measure the value of environmental costs and benefits. These attitudes also affect what policies a government adopts to reduce pollution. (Sloman, 2006)

The social cost of carbon (SCC) measures the damage that carbon and greenhouse gas emission poses and puts money value on it. It estimates the cost of climate change damages, and matters because it signals what society should, in theory, be willing to pay now to avoid the future damage. This value of external cost should be incorporated into government's decisions on policy and investment options. (Department of Energy and Climate Change)

Unfettered markets will always fail to allocate resources efficiently because the price for goods and services can never reflect the true value of these resources resulting in divergence between social and private cost. Therefore the government needs to intervene with regulations. (Turner, Pearce, Bateman, & Ian, 1994)

### **3. Britain's contribution and possibilities**

#### **3.1 Energy use in the UK**

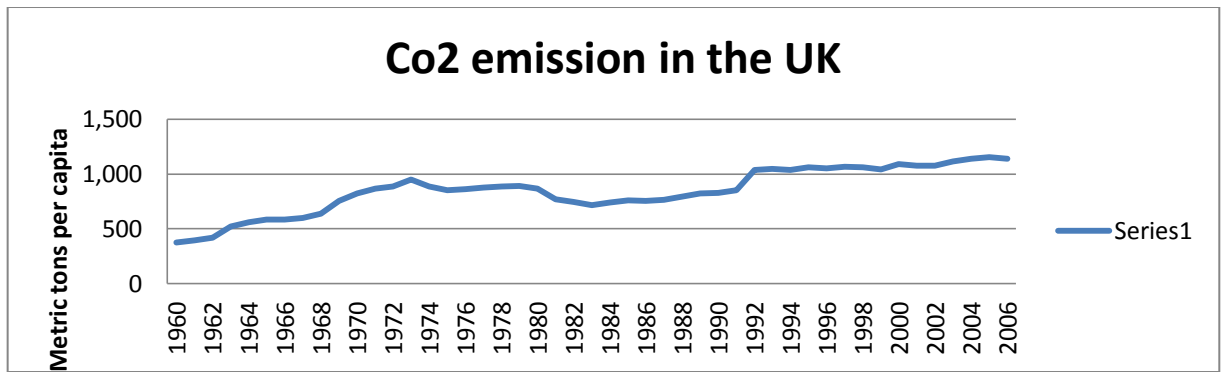
To satisfy the growing needs of humans a considerable increase in energy consumption is necessary, and alongside development in technology throughout history energy consumption has increased. (Goldemberg & Lucon, 2010)

Without energy it would be impossible to heat homes, cook food and or power communications, so civilisation and standards of living depend on adequate supply of energy.

#### *Electric consumption and Co2 emission*

When looking at data from the Worldbank it is clear the electric power consumption per capita in the UK has increased a lot since 1060.

Not surprisingly the same goes for Co2 emission per capita, even though that does not increase as rapidly as the energy consumption.



**Figure 3 Increase in Co2 emission in the UK from 1960 (World data bank)**

The electricity consumption grows very steadily, which seems to follow a better quality of life and constant technology development. It is noticeable that the growth rate of Co2 emission starts slowing down around 1970, which is the same time as The United Nations Conference on the Human Environment in Stockholm and the book *Limits to Growth* was published. (World data bank)

### *Main energy sources*

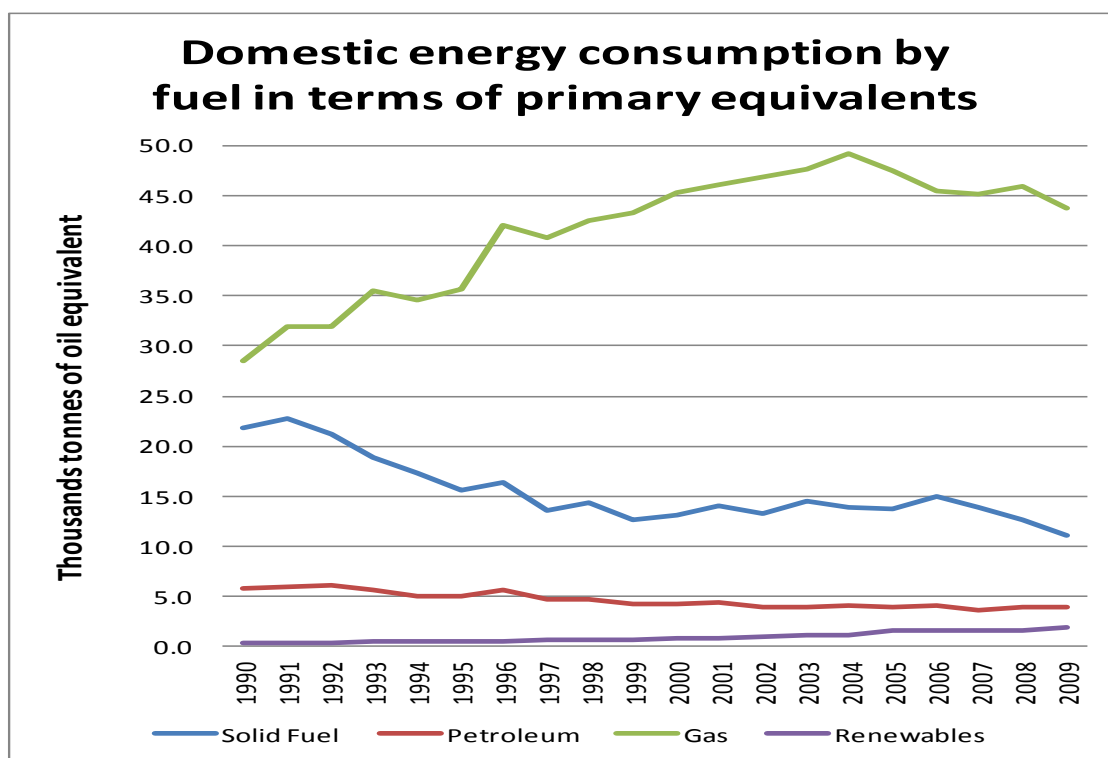
Most of the world's energy comes from fossil fuels, mainly oil and coal. Coal used to be the main energy supplier in the UK for centuries but reached its peak in 1913 and has been steadily declining ever since. The demand for oil then started to increase and around 1970 it became the largest primary energy source in the UK, with coal being the second largest. Since then, the primary energy share of both coal and oil keeps declining, as the use of alternative energy sources such as natural gas, nuclear and solar energy keep growing. (Hill, O'Keefe, & Snipe, 1995)

Since 1970 natural gas did become increasingly preferred to coal for domestic use as a relatively cheap and clean alternative. From 1960 to 1991 coal production dropped from being 200 million tonnes a year to 96 million tonne. (Huby, 1998)

In the 1990s, the UK shifted from carbon-intensive fuels such as coal and oil, towards less carbon-intensive fuels such as gas and nuclear energy.

### *Renewable sources*

Electricity generated from renewable sources increased by 2.2 percent during the year 2010, and heat from renewable sources increased by 17 percent. Renewable energy provisionally accounted for 3.3 per cent of energy consumption which is an increase of 0.3 percent from the year before. (decc.gov.uk)

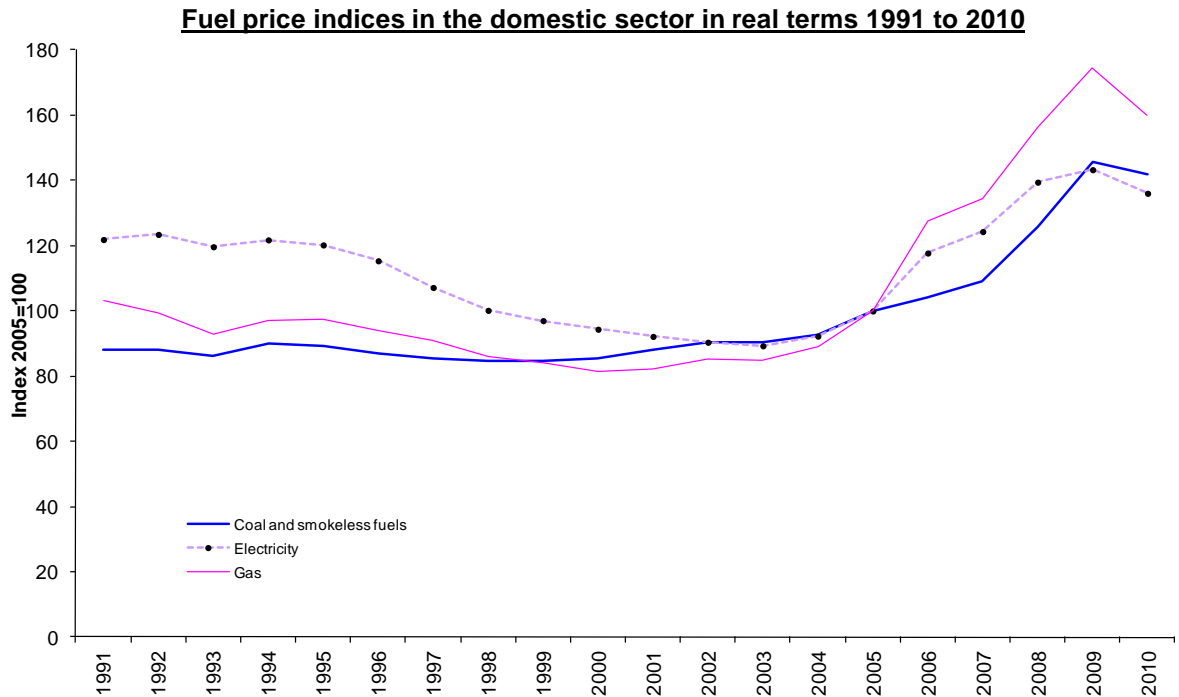


**Figure 4: Domestic energy consumption by fuel between the years 1990 – 2009 (DECC Statistics)**

Figure 4 shows the development of domestic energy consumption by fuel in the terms of primary equivalent between 1990 to 2009. A slight increase in the consumption of renewables is noticeable, but they still only count for a small percentage of the whole consumption.

#### *Development of price*

Energy prices in the UK have increased steadily over the last ten years and there is little prospect of a sustained reversal in these trends, rather more likely than increases will continue. The cash total that households spend on energy has more than doubled over the last ten years, and they spent on average just over 7 percent of all spending on heating, electricity and transport. If a household has to spent more than 10 percent of its income on fuel to maintain satisfactory heating regime they are said to be in fuel poverty. (UK Parliament) Earlier this year the six biggest energy suppliers in the UK all announced huge further price rises and that caused a drastic increase in fuel poverty. A quarter of all UK’s households are now thought to be in fuel poverty. (The Guardian, 2011)



**Figure 5: Fuel prices indices from 1991 – 2001 (DECC Statistics)**

### 3.2 Strategies and policies

#### *International Agreements*

Multilateral Environmental Agreements are agreements between three or more countries that aim to jointly address global issues and regional environmental concerns. There are usually a large number of countries that take part in the agreement which can be embodied in one or more written instrument and governed by international law. The legal systems in individual country acknowledge the Multilateral Agreements which are ratified and incorporated in environmental laws. In June 1992 157 governments met to sign the Rio Declaration. The Rio Declaration set out 27 principles that defined a framework that was meant to govern future policies and specify the obligation of the signature nations regarding environmental issues. (Goldemberg & Lucon, 2010)

#### *The Kyoto Protocol*

The United Nations Framework Convention on Climate Change is an international environmental treaty adopted at the Rio Earth Summit in 1992. The purpose of the treaty was to cooperatively consider options to limit average global temperature

increases and to deal with climate change and its impacts. In 1995 the treaty launched negotiations to strengthen the global response to climate change and in 1997 adopted the Kyoto protocol. (UNFCCC) Over 140 ratified the Kyoto protocol in which developed nations set timed targets for limiting their greenhouse gas emission, and these nations can also engage in emission trading with each other. The UK target is to reduce greenhouse gas emissions by 12,5 percent below base year level. (Government, 2005) The Protocol is legally binding and the first commitment period started in 2008 and ends in 2012. (UNFCCC)

### *European Strategy*

The European Union (EU) prides themselves with having some of the highest environmental standards in the world. In that area they have set different policies aimed at protecting the environment alongside contributing towards economic growth. Their main priorities regarding this are stated to be combating climate change, preserving biodiversity, reducing health problems from pollution and using natural resources more responsibly (Europa) The European Environment Agency (EEA) is an agency of the European Union and with the task of providing reliable and independent information about the state of the environment, as well as ensuring that decision-makers and the general public are kept informed. The EEA has 32 member countries with the U.K being one of them, and focuses on international cooperation as being the only way of addressing environmental issues effectively. (European Environment Agency, 2011)

The EU looks at the energy challenge as one of the greatest tests faced by Europe today, the reason being a continuous rise in prices, huge dependency on energy imports and the problem of climate change. Therefore they have published the 2020 strategy that provides a solid and ambitious European framework for energy policy based around five pillars of action. First priority is to achieve a energy efficient Europe , that translates into 20 percent savings by 2020. Secondly is ensuring free flow of energy by the completion of a truly integrated internal market. Thirdly is providing Secure, safe and affordable energy for citizens and businesses. Forth priority is Extending Europe's leadership in energy technology and innovation that will benefit renewable energy development. Last priority is to strengthen the external



dimension of the EU energy market, which applies to all those EU neighbours who are willing to adopt the EU market model. (Europa, 2011)

The EU is working to reduce the effects of climate change and establish a common energy policy and as part of this policy they have set binding targets to increase the share of renewable energy so that it will account for 20 percent of EU's final energy consumption by 2020. To meet this common target, each Member State has their own target to meet and the target in the UK is 15 percent. (Europes Energy Portal)

### *UK Strategy*

The government uses a set of financial and regulatory instruments to address environmental issues, overcome barriers to energy efficiency and to promote growth of energy from renewable sources. The most important financial instruments are taxes that often reflect externalities, incentives or loans and price policies that aim to reflect the real social cost. The most important regulatory instruments are for example environmental regulations, government purchase policies and integrated recourse planning. Regulation are very effective but to get the best results it is advisable for governments to specify the desired result by means of strategic goals within a specific time limit. (Goldemberg & Lucon, 2010)

Governments often use general publicity campaigns to draw energy conservation and efficiency to the attention of the public, and also make available more specific information about environmental facts and energy efficiency. Governments can impose regulations that set minimum standards for energy efficiency and some governments have introduced or supported voluntary schemes that enable companies for example to advertise the fact that they have achieved particular standard. Government can also have influence on price of energy by taxing less efficient forms of energy more heavily, even though pricing appears rarely to have been influenced by energy efficiency and environmental considerations. On the other hand governments have been known to encourage energy efficiency in the form of subsidising. (Anderson, 1993) The government uses subsidy policies to encourage those activities it wishes to expand. Subsidies from the government can be for example grants for residential users, tax incentives where energy conservation is tax free or loans below market rate. (Anderson, 1993)

### *Securing the future*

The UK Government launched its new strategy for sustainable development, *Securing The Future*, in March 2005. The Strategy takes account of developments since their last sustainable development strategy in 1999, in particular the 2003 energy white paper policy and the outcome from the World Summit in Johannesburg in 2002. The approach consists of providing ministerial leadership and oversight, leading by example, embedding sustainable development into policy and transparent and independent scrutiny. Sustainable consumption and production, tackling climate change and ensuring energy efficiency and natural resource protection are amongst shared priorities for UK action. The UK also acknowledges that they have international responsibilities and aim to show leadership in tackling climate change with continuously working with other countries using the UNFCCC. (Government, 2005)

### *Energy White Paper*

The Government has also issued “white papers” that provide a framework for developing energy policies. The newest one, *Energy white paper 2007: Meeting the energy challenge*, sets out UK’s international and domestic energy strategy in the shape of four policy goals. These goals are aiming to cut emissions further by 2050, maintaining the reliability of energy supplies, promoting competitive markets and ensuring that every UK home can afford to heat their homes. (Department of Energy and Climate Change)

### *The Renewable roadmap*

The UK Government also has in place a renewable energy policy, overseen by the Department of Energy and Climate Change. They are committed to increasing the proportion of energy from renewable sources, which they believe will increase the security of energy supplies in the UK and also provide opportunities for investment in new industries and new technologies. The *Renewable Roadmap* sets out a comprehensive action plan to accelerate the UK’s deployment and use of renewable energy. (Department of Energy and Climate Change)

### *Renewables obligation*

Renewables obligation (RO) places an obligation on the UK electricity suppliers to source a specific and annually increasing proportion of electricity from eligible renewable sources or pay a penalty. The obligation level is set each year by the Department of Energy and Climate Change. (Ofgem)

### *Feed In Tariffs*

The Energy Act 2008 implements the legislative aspects of the Energy white paper 2007: Meeting the energy challenge. On the 1 April 2010 the Feed-in Tariffs was introduced, under the power of the Energy Act. The purpose of these schemes is to help increase the level of renewable energy towards set targets. (Department of Energy and Climate Change)

The Feed In Tariffs allows many people to invest in low-carbon electricity in return for a guaranteed minimum payment for all electricity generated by the system, and also pays a separate payment for the electricity fed back into the national grid. The payment is based on the number of kilowatt hours that are generated. The electricity technologies eligible for Feed in Tariffs include wind, solar photovoltaics (PV) and hydro, but they have to be classed as small-scale which is less than 5 Megawatts capacity. (solarpowerportal) The payment for all electricity generated from PV for domestic use is 41.3 pence per kWh (generation tariff), and the extra payment for the electricity fed back into the national grid is 3 pence per kWh (export tariff). The income from FIT is tax free for home owners in the UK. (bexhillsolar)

### *Renewable Heat Incentive*

The details of the Renewable Heat Incentive policy (RHI) was announced in March 2011. This scheme is the first of its kind in the world and will provide long term support to renewable heat technologies, and guarantees a financial support for those who generate their own heat. It works similar to the Feed in Tariffs, except there is no export tariff and it will be paid for by the Treasury. (Department of Energy and Climate Change)

### 3.3 Energy sources and renewable energy

Primary energy sources are usually classified as commercial, which is used when they are marketed like for example oil and coal, and non-commercial which is used for sources that are free such as the sunlight. Primary energy needs to be transformed into secondary energy which is the form that humans can consume. (Goldemberg & Lucon, 2010)

Natural resources are often categorized as renewable or exhaustible, where renewable refers to resources that regenerate themselves and exhaustible refers to resource that fixed in overall quantity and there for are ultimately finite. However, many renewable resources need to be wise management if they are to be used sustainably. Therefore a better distinction might be between renewable and non-renewable. In the same respect the definition for renewable resource would be a resource that under a suitable management regime regenerates itself. (Turner, Pearce, Bateman, & Ian, 1994)

Renewable sources can be solar radiation, tidal power, geothermal, potential hydraulic energy, wind energy and biomass. Nuclear can also be considered renewable as it consumes small amounts of fuel to generate large amount of power. (Goldemberg & Lucon, 2010)

Renewable energy sources are essentially flows of energy in contrast with non-renewable being, in essence, stocks of energy. Renewable energies are also relatively sustainable in a sense that their environmental and social impacts are generally less than those of fossil fuels, however they can lead to significant visual impact. This is because large areas of land or building surfaces are often required so that big quantities of energy are to be collected. (Boyle, Everett, & Ramage, 2003)

Renewable sources generate electricity which accounts for about one fifth of our total energy consumption. (Hodgson, 2010)

### 3.4 Solar energy

Renewable energy sources, principally solar energy and its derivatives, are increasingly considered likely to play an important role in the sustainable energy system of the future energy needs.

Solar energy makes an enormous contribution to energy needs and civilization on earth. The sun radiates huge quantities of energy into the surrounding space and a tiny fraction of it is intercepted by the earth's atmosphere. It is thought that a third of the intercepted energy is reflected away by the atmosphere before reaching the earth's surface, but even so the continuous flow of power, equivalent to about 10 000 times humanity's consumption of conventional fuels, is available in principle to human civilization

Solar power can be harnessed by using solar collectors to produce hot water and space heating in buildings. This involves the use of a sophisticated technology called solar photovoltaics (PV). PV modules are made of specially prepared layers of semi-conducting materials that generate electricity when sunlight falls on them, and these modules are normally mounted on the roofs of buildings. PV modules can provide some or all of a building's electricity needs, depending on factors such as roof orientation and weather. The use of photovoltaics is increasing globally but at present has a very small share of the world's consumption. This is mainly due to the very high cost of PV modules. (Boyle, Everett, & Ramage, 2003)

Figures show that both the PV cells' efficiency to generate electricity has increased, as well as the cost of each panel has come down with increased production and improved technology. This is projected to be continuous development. The power generation perspectives with photovoltaic panels are promising and they might even become one of the main technologies for future integration of decentralized energy systems. (Goldemberg & Lucon, 2010)

## **4. Household's involvement**

### **4.1 Household's reluctance**

The use of focus groups was chosen to try to gather some information about views and feelings of householders regarding environmental issues, reusable energy and particularly solar panels.

Two focus groups were held, one on 20<sup>th</sup> of October 2011 and the other on 24<sup>th</sup> of October 2011. The duration of both groups was 60 minutes and each group was made of 1 moderator and 6 participants. Participants, who all were house owners in East

Sussex England, were carefully chosen so that the sample would be as reliable as possible. Participants in each group were 3 females and 3 males aged between 30 and 65. The moderator encouraged a free flow of conversations between participants but used the following questions as a guidance to lead the conversations.

Almost all the participants first reaction was that they sometimes think about pollution and the environment but they do not see it as immediate threat as there are other things more important to them, like surviving financially.

The recession and current economic conditions make the public very vary of spending and investing, exemplified by one participant's response regarding spending more on environmental friendly options.

*“At the end of the day we aim to get the best deal- we have to think about what is best for us financially”.*

This view was not isolated and the following comments were very common and agreed on.

*“Maybe if we had a lot of money we might consider paying more for greener products, but at the moment we cannot afford to be responsible”.*

*“We should all do our bit but it can be hard financially”.*

As the conversation was led towards pollution and damage to the environment it became clear that most participants had thought about it and had concerns, and the responses became a bit more positive.

*“We would be open to other possibilities but it has to be worth it for us”.*

*“If you thought it would make a lot of difference regarding pollution I would be prepared to pay more”.*

One focus group felt that everyone should do their bit, and suggested that there should be some kind of assessment done to each household to estimate how green they are and if they meet specific minimum requirements that would be set by the government

*“We think we do what we can like recycling and insulate our house”.*

Everyone had heard about renewable energy, participants had mixed opinions about how green these options actually are.

*“Wind energy was meant to be so green and then suddenly there are complications as to how green it is and reports that it is making more damage than good”*

*“I am not convinced that solar panels are as green as the government wants us to believe”.*

Through the interview it came to light that most participants had thought about solar panels as an option, but the cost of the initial investment that needs to be made had put everyone off. No one had researched the option any further, and therefore there was little knowledge about subsidies from the government.

*“Government keeps coming up with all these new strategies but never seem to follow them through, and they keep changing”.*

*‘I am not sure how much is actually available to householders in the form of grants and help’.*

*“Information is not being fed out to the public enough”.*

Furthermore the visual appearance of solar panels was also an issue, as well as disbelieve that their performance

*“I would not like them to be put on my property, they are big and ugly”.*

*“I am not sure if it would provide us with enough energy in the winter”.*

*“They are probably very expensive to maintain”.*

The results gained from the performance of the two focus groups show clearly that the public lack information about some key factors regarding solar panels. That is information such as the installation cost, if the solar panels will provide enough energy all year around, how long the panels will last for, are they costly to maintain and if they are suitable for any homes. The results also indicate that information about government’s subsidies in the form of grants and feed in tariffs is not a public knowledge. Further to this there is indication that because of change in strategies and

aims, the public lacks enough trust in the government's intentions to let it guide their household investment.

#### 4.2 The cost and benefits of installing solar panels

Like with the focus group, a list of open ended questions was prepared before the interview but during the interview a free flowing dialog was encouraged to allow for the best insight to be gained.

Lee Standell is the founder of the company Bexhill Solar which is located in Bexhill on sea in East Sussex UK. On their website which has the logo "*It pays to be green*" the following text is to be found about the company.

*"We're a small local company that has a real thirst for anything renewable, we were incorporated as a limited company back in August 2009 although we have been involved in the renewable energy sector for many years previously".*

The website also gives information about how solar photovoltaics simply convert light into electricity and solar thermal panels use the sun to heat hot water in a simple way for household use. (bexhillsolar)

Lee worked in the 'Energy' Market for around 7 years, and in this time worked for a company that sold solar panels and other energy saving products. No one else really took an interest in it but he did and ended up running the department. When the company went out of business in 2008, Lee went on to set up his own business in 2009. Since then Lee has seen the demand for solar panels increase slightly on a steady rate.

Lee employs 2 other staff members on full time basis, as well as employing two other people on a subcontracting basis. Lee says ,that if he is honest, his main reason for being in this business is because it is profitable, but he also believes that he is selling a good product, and the fact that it is environmental friendly just adds an extra bonus. He says that he is fully aware that his profit exists because of a government subsidy, that is the feed in tariffs, but he also believes that he is taking part in building a industry that will create a lot of jobs.

Lee was first asked to make a quote for the researcher home. The house is semi-detached with two suitable roof areas, one south facing and the other one south-east



facing. The quote was made on a typical system which is made of two parts, array of solar panels and the inverter.

To start with, the orientation of the roof is important and the shade is also a big issue. When making the quotation a couple of assumptions are used. It is assumed that the inflation is going to go up by 3 percent. It is assumed that 50 percent of generated electricity will be used at home, and 50% will be exported. 10 percent annual increase in energy cost is assumed and assumed price paid per kWh for the power from the energy companies is about 13p. This is a factor which is difficult to work out and comes with a high uncertainty as the energy companies tend to make as confusing as possible, as well as their prices change rapidly. Assumed CO2 savings is 0.517kg per kWh and maintenance cost is put as £0.

A 3 kWh solar system for the property would cost £10.890. On a three kilowatt system on a south facing roof Solar Bexhill estimate that electricity generated will be about 2700 kWh per year. The feed in tariff is paying 43p per kWh for export on tariff. Money saved on electricity bills by using the generated energy around the home estimates at 170 pound a year.

When all this is taken into account the equivalent return on investment is 20 percent and payback time would be just over seven years.

Being small company Lee believes that he offers reasonable price. As an example Lee says that he often does installation for people and who have had quotes from other bigger companies that have been up to 30% higher. Lee believes that what makes his company different from some of the big solar installation companies, is that they are just there to sell, where as a small company like Bexhill Solar has the view that they are here to build up an industry.

Lee says that the returns are really high and in some of his quotation people have been estimated to be getting up to 20% return for their money, which is very high especially in comparison to what the banks are offering at the moment. That is why a lot of his customers are installing solar panels mainly just as an investment opportunity. Lee says that he would like to say that peoples reason for investing in solar panels are because of the environmental benefits as well, but it looks like

the investment opportunity of it and the return from the investment are the main factors that are pushing its demand.

*“The feed in tariffs have bred that mentality that it is a case of getting as many solar panels installed on your property as you possibly can, to get the feed in tariffs and thereby maximize the Return of Investment”.*

Solar has had a bit of a bad reputation in the past with bad sale practices, and are therefore much regulated under different schemes like the consumers protection scheme.

At the moment the solar system is not capable to generate enough energy to be able to just rely on that, house owners still have to rely on the energy companies to top up, for example in the winter when not much is generated.

The solar systems are believed to be working at 80 percent efficiency after being used for 25 years, and Lee thinks that realistically they could last for 40 years. The inverter on the other hand will probably need changing every 10 to 15 years. It is also expected the solar panels are inspected every five years for electrical safety checks. Otherwise they are not expected to cost much to maintain.

Lee is aware that customers sometimes have a problem with what the solar panels look like. He says that the panels are made of two types of crystalline silicon, monocrystalline and polycrystalline. Technically they are both very similar but polycrystalline has a blue colour where as monocrystalline is black and tends to look a bit nicer. Polycrystalline panels were popular because that had a big voltage and could therefore generate more, but in the recent year monocrystalline have been made with just as big voltage. Therefore monocrystalline tend to be more popular despite the fact that they cost more, mainly because they look better.

The interview led to discussions about where people stand regarding their investment if they decide to leave the property. Lee explains that the way the rules are at the moment the feed in tariff payments stay with the property. People should therefore look at the investment as any other improvement to that adds value to the property and should therefore increase the saleability of it.

Then led to discussions about who the scheme is actually available for?

The schemes are available for everyone but there are obvious restrictions as to who can invest in solar panels. To start with you have to be a property owner and it matters what kind of property you own. The geographical positioning and roof orientation matters also. Another fact is that the investment calls for a high money outlet in the beginning and not everyone can access that amount of money.

Lee adds that he has often been approached by companies that want to offer finance to people based on the fact that the actual return of the investment is likely to be higher than the finance would cost.

Lee talks a little about companies that offer free instalment, but does not recommend people going for that they take all the income that will be generated over the 25 year term.

Lee agrees with the view that very little trust in government schemes and the fact that they seem to keep changing them, hinders people in investing by them as they feel that the uncertainty about whether or not the government will honour these agreements add to much risk to the investment

### 4.3 Case Study

Toby O'Dell and his wife Xiaoyan live in Herts in England. They live with their 3 year old son in a semi detached house which they bought in 2002. Toby and his wife would be classed as a middle class couple, they are both educated, both work and have got a joint income.

In May 2011 Toby and his wife decided to invest in having solar panels installed on their property. Toby says that the motivation behind their decision was partly that they had seen their electricity bills increase dramatically and forecast to continue upward, but also because they could not turn down the offer of a deal from a friend.

Toby's friend Richard had retrained as an electrician the year before, and having previously set up and run a market research company and other businesses, was always on the lookout for an opportunity. He gained MCS certification, enlisted a roofer, and set up as a solar installer.

*“Although I had heard about solar, it was him who really introduced me to the potential. Even with a mates-rate quote from him, it still took us a couple of months to agree, as it was to take most of our £8500 savings”*

The type of panels Toby went for were 245 watt panels and they had 12 of them installed. They have two roof areas in their semi-detached house and have plans to extend the house at some point. That will result in two roof slopes becoming one, so they decided to cover both faces and move the panels later once the extension work happens. The result was seven panels on a South-East face, and five on a North-East. An inverter for each is located in the garage because the temperature there more stable than the loft and it is also more convenient, especially as it means them not having to relocate them once they redevelop the loft space into living accommodation.

*“Neither location is ideal, of course, but we're quite happy with the performance so far. The North-East face is obviously underperforming relatively, though we have had a number of days where we had early rising sun for a couple of hours, then heavy cloud, and so that face has produced electricity and the other has not “*

When asked about the environmental benefits Toby thinks they are questionable. The reason for that is that he has heard that the technology used to manufacture the panels is not very green.

*“However, this is probably offset by our overnight appreciation of the environmental improvements we might be contributing to by having solar, and so we are massively more aware about energy wastage. So, obvious things like running the dishwasher and washing machine during the day (specifically in the morning once the inverters start to register some power) but also not using the dryer as much as we did, turning off lights around the house etc. I would liken it to someone joining a gym - they spend the time effort and money improving in the gym, so tend to avoid munching on cakes/biscuits afterwards as they feel it would negate the effort they put in, so the benefits for them are actually twofold without the diet necessarily being their original intention. “*

Toby says that they tend not to look back at the quoted figures, but have been very happy with the returns. In the early days, as it was fitted in May, they were achieving up to 15KWh. Obviously in the autumn it was lower.

*“Richard was very honest about the potential returns, so our expectations were perfectly realistic, and we were surprised to see our electricity meter actually running backwards. Richard also warned us we'd become obsessed by the figures, and he was right, as I still keep a spreadsheet of the daily result.”*

Toby and Xiaoyan have just received their first payment feed in tariff of £620 to cover the first six months from May – October. Realistically they expect the next payment, which will cover the winter months from November – April, to be lower but they are happy with that.

Toby says that they are overall very happy with their investment and have been pleasantly surprised with their returns. When their generated energy is compared to their quoted estimated one they notice that energy generated has actually exceeded the estimation quite significantly.

*“We defiantly made the right decision and now have the pleasure of saving on energy, whilst others are facing raised bills. Thanks to the feed in tariff we can sit back and watch our investment pay off, at least for the moment. Only time will tell if our deal is honoured by this feed in tariffs, and successive governments. They don't have a great record on this”*

## **5. Overview and discussions**

### **Solar panel installment as an green energy option**

Corporations are increasingly showing sustainable responsibility and many by using “Triple bottom line” (TBL) to show achievements. The idea behind it is that that corporations should not only measure profit, but also social and environmental responsibly. TBL consists on the three Ps that is profit, people and planet, and only a company producing TBL is taking account of the full cost involved in doing business. (The Economist, 2009)

The idea behind “the triple bottom” can be used when measuring whether solar panels is a realistic option for households. Therefore all three pillars of the TBS will be taken into

account when deciding on whether solar panels are a realistic option for households in the UK.

It is a fact that development and fast increasing quality of life has made people very dependent on energy. It is used to heat homes and to make all transport fast and easy. Energy is also used to produce electricity which has become something people feel they cannot live without, especially in the developed countries such as the UK.

Most of the world's energy comes from fossil fuels, which over the years has been considered an ideal option. However, in the recent years scientists are always discovering new evidence that proof that the human use of fossil fuels has got consequences.

Increasing demand for fossil fuels has raised concerns regarding the issue that they are finite and will therefore not last forever. That is a big problem that needs to be dealt with for countries like the UK who are extremely dependant on them.

More importantly though is the problem that the use of fossil fuel has caused severe damage to the environment. Some of this damage is non reversible but that does not change the fact that fast action is needed to stop further damage. Research have shown that climate change has reached a point where its pushing planetary boundaries and the burning of fossil fuel is strongly linked to climate change.

Even though environmental awareness can be traced all the way back to the 17<sup>th</sup> century, the concept "sustainable awareness" does not really enter the discussion until in 1987 with "Our Common Future". Up until then it looks like even though people were aware of environmental issues, they looked at it as an isolated issue. This is thought to have been the time when people started to realize that problems such as global warming and infinity of natural resources had a strong relationship with human consumption and economic development. An important milestone was reached as governments acknowledged that action was urgently needed and started letting these views of sustainability influence their policy making.

It is pollution caused by the burning of the fossil fuels that is the problem here, mainly because it is contributing to global warming. Economists see pollution as a negative externality. In other words it is a social cost. That means that someone's consumption of fossil fuels is causing damage that the whole society has to pay for. The economists therefore try to find ways for the social cost to be included in the real price of the good, so that the

consumer or producer is at least accountable for the damage. That is done with government's intervention in the form of subsidies.

One might argue that it is the whole society that is the fossil fuel consumer, and therefore is paying the price already. However research has shown that there is a social difference in the consumption pattern of energy use in the more developed countries like the U.K. Not only do the poor consume less energy than the rich, they also consume different types of energy, therefore causing less environmental impact. (Boyle, Everett, & Ramage, 2003)

Climate change damage is not reversible, which means that the damage being caused by pollution is there to stay. Therefore today's consumptions is also damaging for future generations.

There is also a great difference in consumption between countries, as it is well known that the developed countries use a lot more energy than the underdeveloped ones. They should therefore not have to pay the price in the form of climate change.

This is why national co-operation is so important regarding this matter. National agreements are often legally binding and influence the participating countries policy making. The EU also has an energy strategy that underlines the importance of tackling climate change and protecting energy resources. Their strategy framework also puts importance on encouraging innovation and research in the renewable energy market.

Influenced by national agreements, such as the "Kyoto Protocol", and by the EU strategy, the UK has their own strategy for sustainable development as well as a special framework for developing energy policies. Under these they have developed policies that encourage the use of renewable energy, and as subsidies bridge the gap between social cost and real cost. Examples of these subsidies are "The renewable Obligation" and "The Feed in Tariffs".

This brings up an interesting question as to what extend consumers feel that they are responsible, if at all, with their consumption of fossil fuels? Also if they would be prepared to bear some of these social costs themselves by for example opting for greener options even if it costs them a bit more. Do they feel that the government should have all the responsibility of dealing with environmental issues, and do they have trust in these government schemes?

This was what the researcher aim was to find out by performing the focus groups. Furthermore to lead the conversations towards finding out if renewable sources were considered an option, and in that respect especially solar panels.

The results were quite distinctive and maybe a little bit surprising. They showed that despite ever growing awareness of environmental issues and sustainability, people generally do not feel that the responsibility should be theirs. The common view was that even though everyone should show some responsibility with their actions, it should not have to cost them anything financially. The research showed that the public has not got a great trust in the government's schemes, and did not feel that information about these schemes were being fed out to them properly. Participants did not know enough about solar panels and the feed in tariff scheme to have considered them as an option for their households.

Renewable source has been defined as a source that under a suitable management regime regenerates itself. Renewable energies are relatively sustainable as their social and environmental effects are minimal. These qualities make renewable energy sources a popular option as a solution to the energy challenge that the uses of fossil fuels are causing.

The renewable option available for households is in the form of solar power that can be harnessed using solar collectors to produce water heating and energy. The use of solar energy is increasing but the main threshold is that it requires a high initial investment. However improved technique and development has both improved efficiency and pushed the prize down.

### **Solar panels as an financial option**

The second primary research undertaken was in the form of an interview and a quote for instalment. The results from that gave an insight into limitation regarding this investment. Not everyone can invest in solar panels and the magnitude of these benefits depends on different factors.

To start with is this only an investment option for homeowners, because of the fact that the electricity use and the feed in tariff payments stay with the property.

Another consideration is the geographical location of the property. There is more sunlight that can be generated over the year in the south of England ,for example, than in the north. The same goes for the orientation of the roof, where south facing roof would generate the most.



The results also showed that the financial benefits gained for households from installing solar panels can be very significant.

The fact that Feed In Tariffs (FIT), pays for every electricity generated, regardless of if it will be used or not, has got high bearings.

Firstly because of the fact that it involves saving on energy bills. The UK's households have seen their energy bill increase significantly over the last decade and a quarter of all households are now classed as being in fuel poverty. When all the big energy firms announced a further huge rise in prices earlier this year, householders became even more worried and uncertain about future developments.

Secondly because the cash flow that the FIT provides is in the form of a tax free income for households. The quote that researcher had received from Bexhill Solar (see table) shows that investment of £10.890 could see the income of £1.171 FIT revenue for that property in the first year. Addition to that would be the income £42 in export revenue and up to £176 in electricity savings.

When making a making a decision about investing in something there are many factors to consider. For households, an investment in solar panels would be looked at as capital investment decision, an investment that involves current outlay in return for a stream of benefits in future years. (Drury, 2006)

From household's point of view, investing in solar panels requires a very high initial outlay and the investment covers many years. The time value of money matters. Each pound of present expenditure is not equal to each pound received in the future. There are three reasons for this. The investment has opportunity cost, which means that the money invested is tied up in the investment and can therefore not be invested elsewhere. There is also the effect from inflation, which means that money loses its purchasing power over time. The third factor is risk, every investment has a risk and for every pound that is invested there is always a degree of uncertainty about future receipts. (McLaney, 2002)

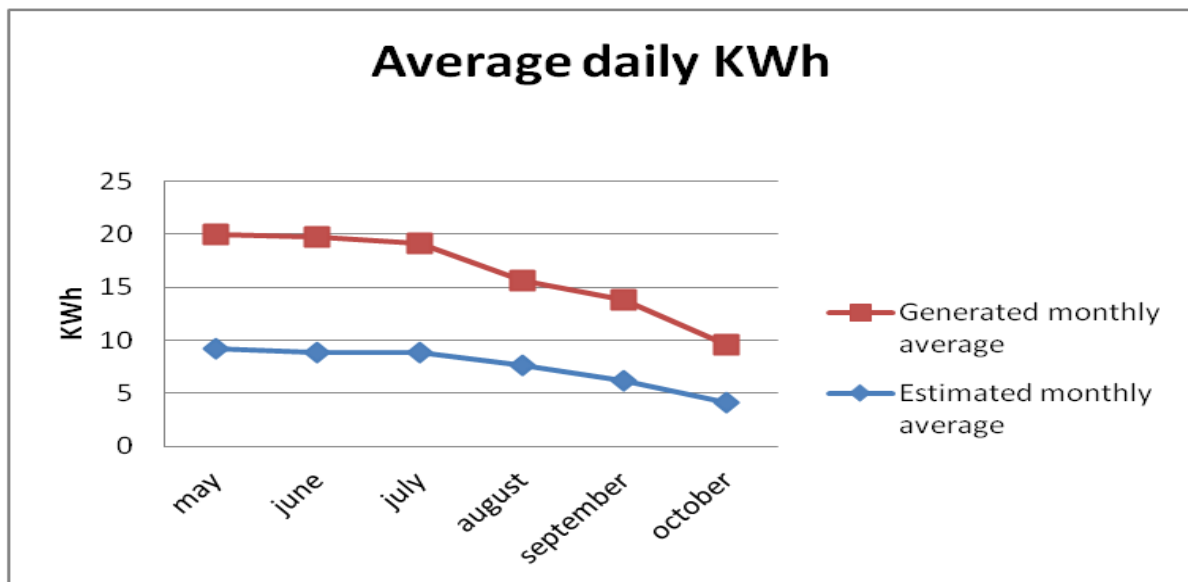
Therefore it can be useful to calculate the Net Present Value of the investment in addition to Payback time and Return on Investment.

Net present value is an investment appraisal technique that is based on the cash receipts and payments associated with a project, discounted according to how long each cash flow will occur in the future.

Payback period is an investment appraisal technique that assesses how long it takes for the initial cash investment to be repaid from the cash receipts from the investment.

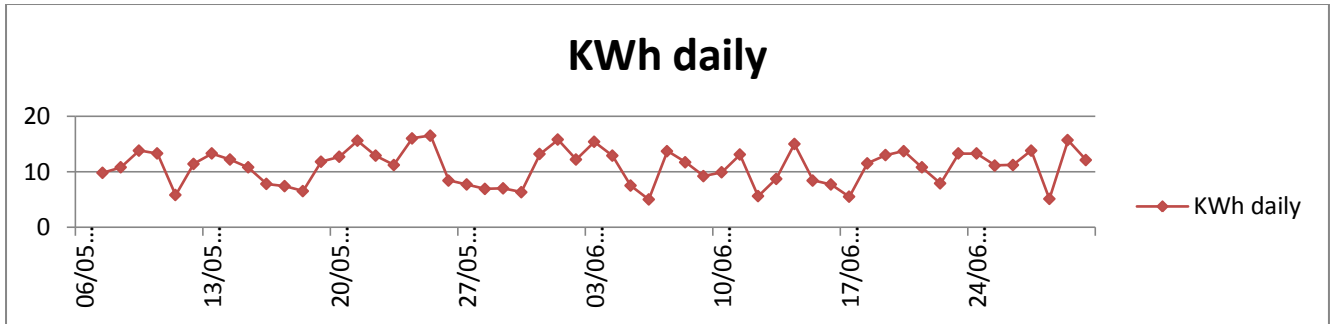
Return on investment (ROI) is an investment appraisal technique that assesses the average accounting profit as a percentage of the investment. (McLaney, 2002)

Calculated NPV of the investment in solar panels using the numbers from the quote is £17,102. The discount rate of 5% was used. That means that investing in solar panels today is worth £17,102 more than investing somewhere where the interest rate is 5%. Banks in the U.K are currently offering between 3 and 4 % on their savings accounts. (moneyfacts.co.uk) However, investing in solar panels would be considered to have a higher risk factor. It is also worth keeping in mind that interest income is taxed but FIT are tax free.



**Figure 6: Estimated and generated kWh data from case study**

It might be questionable how realistic quotes from the solar companies are. Figure 6, which is made from data from the case study, shows that electricity generated for the first six months has actually exceeded the estimation in their quotes which would result in higher income for the first year. Figure 7 shows clearly how kWh generated varies each day, and income could therefore be quite different from year to year depending on factors like the weather and positioning of clouds.



**Figure 7 Generated daily kWh data from case study.**

*Changes to FIT*

During this research, or on the 31 October 2011, the UK Government announced their plans to cut the feed-in tariffs available to domestic and small-scale business installations, from 43p per kWh to just 21p per kWh. On the same day The Department of Energy and Climate Change (DECC) launched a consultation on the proposed changes on their website.

This consultation invites comments on the Government’s proposals for the tariff levels available for renewable electricity generation from solar PV installations of 250kW or below under the Feed-in Tariffs scheme (FITs). This consultation applies to England, Wales and Scotland only.

*FITs was introduced on 1 April 2010, under powers in the Energy Act 2008. Through the use of FITs DECC hopes to encourage deployment of additional small scale (less than 5MW) low carbon electricity generation, particularly by organisations, businesses, communities and individuals who have not traditionally engaged in the electricity market.*

*This will allow many people to invest in small scale low carbon electricity, in return for a guaranteed payment for the electricity they generate and export.*

*Deployment of PV, has, in recent months, accelerated rapidly. Combined with falling installed costs (by at least 30%) and a number of other factors including rising electricity prices, this means that returns available to new generators are higher than envisaged.*

*This is not sustainable and the tariffs proposed reflect these developments.*

*We also propose prioritising energy efficiency by linking PV tariffs to specified minimum energy efficiency requirements from 1 April 2012. We are also proposing new multi-installation tariff rates for aggregated solar PV schemes, applying to new installations with an eligibility date after 1 April 2012.* (Department of Energy and Climate Change, 2011)

This backs up the result that, because of FIT, installing solar panels is an investment that can give very high returns. The purpose of these schemes is to help build up an industry and to reach set target. The FIT are a government's subsidy funded from consumers energy bills and it does not sit right that some people are earning a lot of money from it. Greg Barker, the UK's Minister of State for Energy and Climate Change, addressed this on a solar industry gathering in October this year.

*“Much of the growth in PV has been as much about consumers accessing the Government-backed tariff as accessing the technology. High net worth individuals chasing returns which are now easily reaching double figures at a time when interest rates for savers have collapsed to an historic low. That can't be right. And I know responsible voices in the industry have been worried about this for some time,”* (Solar Power Portal, 2011)

Greg Barker went on to introduce proposals to ensure that all new domestic PV sites from April 2012 must meet minimum energy efficiency standards.

*“It cannot be right to encourage consumers to rush to install what are still expensive electricity generating systems in their homes before they have thoroughly explored all of the sensible options for reducing their energy consumption first,”* (Solar Power Portal, 2011)

To try to get a feeling for what this might mean for consumers, the original quote from Bexhill Solar was recalculated using the new feed in tariffs rate of 21p per kWh generated.

The changes would bring the payback time to 11.3 years, ROI to 319% equivalent to 12, 8%. The NPV using the discount rate of 5% would come down to £6584.

## 6. Conclusion

The aim of this study was to answer the research question:

*Solar panels, an realistic option for households in the UK?*

The conclusion is based on three factors. These factors are society, environment and profit.

There is a social difference in energy consumption where the richer tend to use more. Today's energy sources are strongly linked to pollution, so more consumption in that respect means more pollution and more cost to the society. Solar panels have been proven to cause a lot less pollution, as well as encourage energy efficiency. Therefore opting for solar panels can be seen as a socially responsible option.

The same goes for the environment. The government aims to increase the use of renewable energy to reach the goals they have set in their tackle of climate change. In same respect households opting for solar panels can be seen as making an environmental friendly choice.

It has been shown that investing in solar panels has many financial benefits. As well as saving on energy bills it also provides tax free income. This income has higher returns than investing in a bank, even after the feed in tariffs have been cut.

However there are limitations, as not every household is in a position to invest in solar panels.

For the households who can, investing in solar panels is not only a realistic option, but could prove be extremely beneficial and sustainable choice.

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## Appendixes

### Appendix 1 - Question guide used for focus groups

**Do you think about environmental issues and pollution?**

**Do you feel that you have responsibilities in that matter as household owners?**

**Do you feel that the government has responsibilities?**

**What do you know about renewable energy?**

**If you were offered renewable energy for your household for a slightly higher price than your current one, would you consider that?**

**What matters when you make these choices, is it just price?**

**Have you consider solar panels as an option?**

**What do you know about solar panels?**

**What do you like and dislike about them?**

**Do you think that you are getting the right information about solar panels?**

**What would you like to know?**

## Appendix 2 - Question guide for interview

**How much is the Initial cost and installation?**

**How many solar panels do you need per square meter?**

**How long would it take to get the investment back?**

**Will solar panels provide enough energy, particularly in the winter?**

**What is the lifetime of solar panels?**

**How environmental friendly are the solar panels themselves, what are they made from and how will they be disposed of?**

**How much does it cost to maintain them and is it easy to get them repaired if something goes wrong?**

**Are they suitable for any homes?**

**What grants are available and are they available to everyone?**

## Appendix 3 - Set up quote for solar panel instalments

	Produce	Efficiency	FIT Rate	FIT including	FIT Revenue	Cost of	Electricity	Export	Annual	Cumulative	
	kWh	of cells	(Kw/h) (p)	inflation	(£)	Electricity (£)	Saving (£)	Export Rate (p)	Revenue (£)	Benefit (£)	Benefit (£)
Year 1	2704	100%	43.3	43.3	1170.83	0.13	175.76	3.1	41.91	1388.50	1388.50
Year 2	2704	100%	43.3	44.6	1205.96	0.14	193.34	3.2	43.17	1442.46	2830.97
Year 3	2704	100%	43.3	45.9	1242.14	0.16	212.67	3.3	44.46	1499.27	4330.24
Year 4	2677	99%	43.3	47.3	1266.61	0.17	231.60	3.4	45.34	1543.54	5873.78
Year 5	2650	98%	43.3	48.7	1291.43	0.19	252.18	3.5	46.23	1589.84	7463.62
Year 6	2623	97%	43.3	50.2	1316.60	0.21	274.57	3.6	47.13	1638.30	9101.91
Year 7	2596	96%	43.3	51.7	1342.11	0.23	298.91	3.7	48.04	1689.07	10790.99
Year 8	2569	95%	43.3	53.3	1367.98	0.25	325.38	3.8	48.97	1742.33	12533.31
Year 9	2542	94%	43.3	54.9	1394.18	0.28	354.15	3.9	49.91	1798.24	14331.56
Year 10	2515	93%	43.3	56.5	1420.73	0.31	385.42	4.0	50.86	1857.01	16188.57
Year 11	2488	92%	43.3	58.2	1447.62	0.34	419.41	4.2	51.82	1918.85	18107.42
Year 12	2461	91%	43.3	59.9	1474.84	0.37	456.33	4.3	52.79	1983.97	20091.39
Year 13	2434	90%	43.3	61.7	1502.39	0.41	496.45	4.4	53.78	2052.62	22144.01
Year 14	2434	90%	43.3	63.6	1547.47	0.45	546.09	4.6	55.39	2148.95	24292.96
Year 15	2407	89%	43.3	65.5	1576.18	0.49	594.03	4.7	56.42	2226.63	26519.59
Year 16	2380	88%	43.3	67.5	1605.22	0.54	646.09	4.8	57.46	2308.78	28828.37
Year 17	2352	87%	43.3	69.5	1634.59	0.60	702.62	5.0	58.51	2395.73	31224.10
Year 18	2325	86%	43.3	71.6	1664.28	0.66	764.00	5.1	59.58	2487.86	33711.95
Year 19	2298	85%	43.3	73.7	1694.27	0.72	830.63	5.3	60.65	2585.55	36297.51
Year 20	2271	84%	43.3	75.9	1724.57	0.80	902.94	5.4	61.73	2689.25	38986.75
Year 21	2244	83%	43.3	78.2	1755.16	0.87	981.41	5.6	62.83	2799.40	41786.16
Year 22	2244	83%	43.3	80.6	1807.82	0.96	1079.55	5.8	64.71	2952.09	44738.24
Year 23	2217	82%	43.3	83.0	1839.62	1.06	1173.20	5.9	65.85	3078.67	47816.91
Year 24	2190	81%	43.3	85.5	1871.70	1.16	1274.78	6.1	67.00	3213.48	51030.40
Year 25	2163	80%	43.3	88.0	1904.05	1.28	1384.95	6.3	68.16	3357.16	54387.56

<b>Cost of Installation</b>	<b>10889.55</b>	<b>Payback Time 7.1 years</b>	<b>Return on Investment</b>	<b>499%</b>	<b>Equivalent to: 20.0%</b>
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## Appendix 4-Recalculated quote for solar panel instalments

	Produce	Efficiency	FIT Rate	FIT including	FIT Revenue	Cost of	Electricity	Export	Annual	Cumulative	
	kWh	of cells	(Kw/h) (p)	inflation	(£)	Electricity (£)	Saving (£)	Export Rate (p)	Revenue (£)	Benefit (£)	Benefit (£)
Year 1	2704	100%	21	21.0	567.84	0.13	175.76	3.1	41.91	785.51	785.51
Year 2	2704	100%	21	21.6	584.88	0.14	193.34	3.2	43.17	821.38	1606.89
Year 3	2704	100%	21	22.3	602.42	0.16	212.67	3.3	44.46	859.56	2466.45
Year 4	2677	99%	21	22.9	614.29	0.17	231.60	3.4	45.34	891.23	3357.67
Year 5	2650	98%	21	23.6	626.33	0.19	252.18	3.5	46.23	924.74	4282.41
Year 6	2623	97%	21	24.3	638.53	0.21	274.57	3.6	47.13	960.23	5242.65
Year 7	2596	96%	21	25.1	650.91	0.23	298.91	3.7	48.04	997.87	6240.52
Year 8	2569	95%	21	25.8	663.45	0.25	325.38	3.8	48.97	1037.80	7278.32
Year 9	2542	94%	21	26.6	676.16	0.28	354.15	3.9	49.91	1080.22	8358.54
Year 10	2515	93%	21	27.4	689.04	0.31	385.42	4.0	50.86	1125.32	9483.86
Year 11	2488	92%	21	28.2	702.08	0.34	419.41	4.2	51.82	1173.31	10657.17
Year 12	2461	91%	21	29.1	715.28	0.37	456.33	4.3	52.79	1224.41	11881.57
Year 13	2434	90%	21	29.9	728.64	0.41	496.45	4.4	53.78	1278.87	13160.45
Year 14	2434	90%	21	30.8	750.50	0.45	546.09	4.6	55.39	1351.99	14512.44
Year 15	2407	89%	21	31.8	764.43	0.49	594.03	4.7	56.42	1414.88	15927.32
Year 16	2380	88%	21	32.7	778.52	0.54	646.09	4.8	57.46	1482.07	17409.39
Year 17	2352	87%	21	33.7	792.76	0.60	702.62	5.0	58.51	1553.89	18963.28
Year 18	2325	86%	21	34.7	807.16	0.66	764.00	5.1	59.58	1630.73	20594.01
Year 19	2298	85%	21	35.8	821.70	0.72	830.63	5.3	60.65	1712.98	22307.00
Year 20	2271	84%	21	36.8	836.40	0.80	902.94	5.4	61.73	1801.07	24108.07
Year 21	2244	83%	21	37.9	851.23	0.87	981.41	5.6	62.83	1895.48	26003.55
Year 22	2244	83%	21	39.1	876.77	0.96	1079.55	5.8	64.71	2021.04	28024.58
Year 23	2217	82%	21	40.2	892.19	1.06	1173.20	5.9	65.85	2131.25	30155.83
Year 24	2190	81%	21	41.4	907.75	1.16	1274.78	6.1	67.00	2249.54	32405.37
Year 25	2163	80%	21	42.7	923.44	1.28	1384.95	6.3	68.16	2376.55	34781.92

<b>Cost of Installation</b>	<b>10889.55</b>	<b>Payback Time 11.3 years</b>	<b>Return on Investment</b>	<b>319%</b>	<b>Equivalent to: 12.8%</b>
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