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ADDRESSING CLIMATE CHANGE AND THE ROLE OF TECHNOLOGICAL SOLUTIONS

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Abstract: As far as sustainability is concerned, the role of technology has always been contested. With regard to environmental degradation, technology is either perceived to be part of the problem or part of the solution. To combat the complex issues of the present time, technological solutions are expected to play a key role towards mitigating and adapting to the negative impacts of climate change. The paper also discusses the role of the 2009 Copenhagen Conference towards addressing climate change. Although the Copenhagen Accord is not a legally binding agreement, it is seen as a necessary first step towards a protocol that will effectively address the issue of climate change.

Key words: Climate change, Copenhagen Conference 2009, Sustainable future, Technological solutions

Introduction

As far as sustainability is concerned, the role of technology has always been contested (Healy, 1995; Omer, 2008b). Omer (2008b) states that any discussion concerning sustainability must not neglect the ability of technology. With regard to environmental degradation, technology is either perceived to be part of the problem or part of the solution (Elliot, 2006; Omer, 2008b). Technology forms part of our everyday life from transportation such as cars, trains and planes to home appliances such as microwaves, computers and televisions. It should be acknowledged that science and technology are considered to enhance growth and socio-economic development of a nation (Peter *et al.*, 2006). Industrial activity with the application of carbon intensive methods of energy production has been blamed for warming the climate and when coal, oil and gas are burnt, they emit harmful greenhouse gases which trap heat in the earth's atmosphere (Omer, 2008b). Global climate change and its negative consequences represent a serious challenge and significant threat to the physical and human environment that needs to be tackled effectively without delay (Moriarty and Honnery, 2008; Tjernstrom and Tietenberg, 2008). Addressing the issue of climate change and its global impacts is seen as a major priority, particularly in those parts of the world where people are unable to afford the infrastructural responses that are required to tackle human-induced climate change (George and Page, 2004; Whalley and Walsh, 2009). This paper aims to evaluate the contributions of technology in respect to achieving a sustainable future with reference to global climate change and questions how far it is true to say that technology is the best way forward to achieving this goal. This will be illustrated by making particular reference to intense debate over energy security, supply and climate change and what technological solutions are available to address the negative

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consequences of climate change and achieve a sustainable future.

The concept of sustainable development, climate change and the role of technology

Peter *et al.* (2006) comment that in the last 30 years several important milestones have demonstrated the growing importance of realising a sustainable future (Elliot, 2006). The environment became an important international issue in 1972 at the United Nations Conference on the Human Environment and 20 years later, the 1992 Earth Summit in Rio de Janeiro, Brazil concluded the protection of the environment to be linked to the need for sustainable development (Peter *et al.*, 2006). For the purposes of this paper, sustainable development is defined as

> "...development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (Elliot, 2006: 7).

The Rio Declaration on Environment and Development linked the protection of the environment to the need for sustainable development with Agenda 21, which operates as a global action plan for the concept of sustainable development that integrates environmental, economic and social concerns into a single policy (Peter *et al.*, 2006). The challenge of implementing sustainable development in practice, with particular reference to climate change remains an ongoing issue. The Intergovernmental Panel on Climate Change (IPCC) states that the observed temperature increases in the earth's atmosphere were the result of anthropogenic interactions with the environment, primarily the burning of fossil fuels and deforestation, which has led to human-induced climate change (IPCC, 2007). Although the IPCC acknowledges that natural phenomenon such as volcanic activity and solar variations produced temperature fluctuations in pre-industrial times, human activity has significantly altered the chemical composition of the atmosphere, particularly carbon dioxide (CO_2), one of the greenhouse gases that contribute to anthropogenic climate change (IPCC, 2007; Moriarty and Honnery, 2008). Another key issue that was addressed at the 1992 Earth Summit in Rio de Janeiro was the issue of climate change which led to an important agreement on the Climate Change Convention, which in turn led to the Kyoto Protocol, established in 1997 aimed at combating climate change and stabilising greenhouse gas (GHG) emissions in the atmosphere. The Kyoto Protocol was an internationally symbolic expression of concern regarding climate change however; Prins and Raynor (2007) argue that as an instrument for achieving emissions reductions, it has failed. The Kyoto Protocol has produced no demonstrable reductions in GHG emissions, pays little attention to the needs of nations to adapt to climate change and is regarded as setting minimal emission reduction targets (Prins and Raynor, 2007). The United Nations Climate Change Conference (COP-15) took place in Copenhagen from the 7th – 18th December 2009 with an aim to set out details for an agreement that would take over from the Kyoto Protocol which is set to expire in December 2012 and would aim to address the issue of climate change and the action necessary to reduce the rate at which the earth's atmospheric temperature is increasing.

Healy (1995) comments that for society, technology provides an infrastructure which helps us to communicate with one another through various mediums such as telecommunications and the internet (Peter *et al.*, 2006; Watanabe, 2008), understand the world we live in through developments in ICT in educational institutions which then inspires innovation further (Sanchez and Salinas, 2008; Obijiofor, 2009), move from place to place relatively quickly and efficiently using transportation methods that have rapidly developed over time such as cars, trains and planes. For people in the developed world, technology helps to supply us with energy for our luxurious lifestyles (Omer, 2008a; Omer, 2008b). Technological developments now make remote sensing possible to obtain information about an area or phenomenon without necessarily being close to that area or occurrence (Chern *et al.*, 2008; Hongjun *et al.*,

2008; Obijiofor, 2009). Furthermore, this allows for the monitoring and managing of areas or phenomenon that may affect society, either positively or negatively such as weather events or volcanoes (Chern *et al.*, 2008; Hongjun *et al.*, 2008; Obijiofor, 2009). Huber (2008) comments that technological innovations in regard to the environment are able to progress and become more efficient such as clean-burn technologies (in furnaces and motors), fuel-less energy such as photovoltaic's and geothermal flows and introducing sound ecological practices in combination with high-tech farming (biotechnology). It should be acknowledged that technology is part of our everyday life and has significant importance in relation to economic development and growth.

Technology: Part of the problem?

It has been continuously debated about how technology can achieve a sustainable future with regard to global climate change as many would argue that technology, development and more specifically industrialisation created an unsustainable future (Omer, 2008b). Up until the late eighteenth century, the global society had established what we refer to now as a 'solar economy' with energy entirely derived from the sun in one form or another, with few exceptions (George and Page, 2004). Vast stores of energy in the earth's crust such as coal and oil were unlocked and utilized during the Industrial Revolution, which is known as the 'carbon economy' (Omer, 2008b). Omer (2008b) states that industrial activity with the application of carbon intensive methods of energy production has been blamed for warming the climate and when coal, oil and gas are burnt, they emit harmful greenhouse gases which trap heat in the earth's atmosphere. The release of gases such as CO_2 builds up in the atmosphere, exaggerating the impact of the greenhouse effect which influences the global climate and increases the average global atmospheric temperature. This is known as the 'enhanced greenhouse effect'. Verbruggen (2007) states that over the last 650,000 years, CO_2 concentration within the earth's atmosphere never surpassed 300ppm, however, following the industrial revolution and exponential growth of fossil fuel usage, CO_2 concentration in 2005 measured 380ppm (Gore, 2006). Environmental degradation caused by the extent and the approach of energy use are now the subject of intense political and public concern (Verbruggen, 2007).

> "Energy sustainability is becoming an increasing issue – or rather "the" issue in our society" (Schweizer-Ries, 2007: 4126).

As a result of anthropogenic interactions with the physical environment having significantly increased the atmospheric concentrations of CO_2 and other greenhouse gases in the atmosphere, the average temperature of the earth's surface is increasing (IPCC, 2007; Omer, 2008a). Golait *et al.* (2009) comment that this calls for urgent measures for minimising, if not replacing the heavy reliance on fossil fuels to meet rising global energy requirements in response to exponential population growth (Omer, 2008a; Omer, 2008b). Global climate change poses a serious challenge and significant threat to our life-support systems and our way of life, which needs to be tackled effectively without delay with a clear focus on mitigation and adaptation (Verbruggen, 2007; Moriarty and Honnery, 2008; Tjernstrom and Tietenberg, 2008).

Impacts on human and natural systems will be severe and potentially irreparable, unless mitigative action is taken to stabilise atmospheric greenhouse gas concentrations (Lorenzoni *et al.*, 2007). As a consequence of the global society's excessive dependence on fossil fuels and energy dependent lifestyles, strategies for achieving climate change mitigation and adaptation will require major changes at individual, regional, national and international levels (Pidgeon *et al.*, 2008; Zografakis *et al.*, 2008). The predicted global temperature increase of between 1 and 5 degrees, could lead to potentially catastrophic environmental impacts (Omer, 2008a). The negative consequences of climate change include sea level rise, increased frequency of extreme weather events, floods, droughts and possible stalling of the Gulf Stream which will,

in turn, have a major impact on human life and the built environment (IPCC, 2007; Moriarty and Honnery, 2008). Any argument that considers the nature of the negative consequences of global climate change must also consider the secondary impacts which include conflict regarding basic and natural resources, implications for food security, impacts on the global economy, water shortages, mass migrations, displacement following natural disasters and an increase of environmental refugees as a result of the consequences of human-induced climate change (Gore, 2006). Delaying effective response to climate change may be politically easier in the short term, but will entail higher overall costs and more eventual disruption (Moriarty and Honnery, 2008; Omer, 2008a). Furthermore, the longer we wait to act upon reducing GHG emissions proactively, the greater the risk of irreversible adverse change, and the harder it will be to reduce emission levels (Moriarty and Honnery, 2008). To keep the threatening dynamics of climate change within a scope of control, it is urgent to reduce the increasing concentration of CO_2 and GHG emissions in the atmosphere (Gore, 2006; Verbruggen, 2007). Although the dangers of climate change are apparent, Verbruggen (2007) comments that many experts expect fossil fuels to remain the dominant energy source at least during the first half of the 21st century. Drastic reductions of global GHG emissions will need to be rapidly implemented in order to combat global climate change and its negative consequences (Verbruggen, 2007; Moriarty and Honnery, 2008). Midilli *et al.* (2006) comments that technological development can be part of the problem for hindering our ability towards achieving a sustainable future, especially within the context of human-induced climate change (Omer, 2008b).

Technology: Part of the solution?

Pacala and Socolow (2004: 968) argue that the global society *"...already possesses the fundamental scientific, technical and industrial know-how"* to bring about substantial emission reductions to 'solve' the issue of climate change for the next half-century. There is however, some confusion regarding current options for mitigation technology with the IPCC claiming that current technologies exist in operation or in the development stage which are sufficient to follow a less than double trajectory of carbon emissions over the next hundred years (Pacala and Socolow, 2004). In opposition to this claim by the IPCC, Hoffert *et al.* (2002) state that revolutionary changes in mitigation technology such as nuclear fusion and space-based solar electricity are required to meet essential emission reduction targets. Although the call for the development of new technologies is welcomed by many, Pacala and Socolow (2004) comment that it is important not to be distracted by revolutionary technology that will inevitably take time to develop and focus on the existing technology to combat global climate change. In order to keep a focus on current technologies to achieve emissions reductions, Pacala and Socolow (2004) argue that carbon emissions can be significantly reduced to pre-industrial levels by dividing emission reduction targets into seven segments, referred to as 'stabilisation wedges'. To solve the issue of climate change and its negative consequences from occurring, carbon emissions that are released should be frozen at their current levels for the next 50 years (Pacala and Socolow, 2004). To fill all seven 'stabilisation wedges' and to stabilise GHG emissions, numerous technologies and/or lifestyle changes need to be utilized. Such strategies include domestic energy efficiency, increasing the usage of public transport, reducing the reliance on cars, shifting from carbon intensive sources of energy to carbon free sources of energy such as tripling the world's use of nuclear energy, developing carbon capture and storage techniques and increasing the amount of renewable energy sources such as solar, geothermal, hydroelectric and wind power (Pacala and Socolow, 2004; BBC News, 2009a).

There is no single option that exists to address the negative consequences of global climate change however, technology can also be part of the solution for combating human-induced climate change, for example; the use of renewable (or green) energy sources is a

fundamental factor for energy policy in the future (Kajikawa *et al.*, 2008; Zhixin *et al.*, 2009). Green energy can be defined as an energy source which has zero or minimum environmental impact (Midilli *et al.*, 2006). Pacala and Socolow (2004) support the claim that although technical strategies to combat climate change are important, no single element is a credible candidate to achieve significant emissions reductions alone. Furthermore, Abulfotuh (2007) states that taking into account the sustainable character of the majority of renewable energy technologies, the rationale behind their application is their ability to be able to preserve resources and to provide security, diversity of energy supply and services, a clean and efficient energy source, virtually without environmental impact (Omer, 2008a; Zhixin *et al.*, 2009). There are a wide range of renewable energy sources such as solar, hydro, wind, biomass and geothermal (Verbruggen, 2007; BBC News, 2009a). However, it requires effective technology to convert renewable energy sources into electricity and apart from their sustainable appeal and low-carbon intensity, renewable energy is an expensive investment and in a world concerned with energy intensive practices and continued growth, they are economically unresponsive (Verbruggen, 2007; Omer, 2008b). Golait *et al.* (2009) and Zhixin *et al.* (2009) comment that in Denmark, 20% of the energy is supplied by wind power and aims to increase the power from wind farms, mostly offshore to 50% by 2025 aiming to secure a sustainable energy future. Zhixin *et al.* (2009) states that Denmark, Britain, Ireland, Sweden and the Netherlands are developing offshore wind power rapidly.

Shanghai, China is also using this approach for its lack of primary energy, the majority of which is dependent on foreign imports. Shanghai has a massive power demand which is 60% covered by coal consumption which puts great pressure on the environment (Zhixin *et al.*, 2009). Shanghai's location is frequently subjected to south and north winds and being China's Yangtze River estuary, it is rich in wind energy resources and creates the ideal region and great potential for wind power development (Zhixin *et al.*, 2009). The costs of using coal for Shanghai's power demand, environmentally, economically and socially are great and are resulting in severe negative impacts. Therefore, the potential to develop cleaner sources of energy is seen as a future route towards sustainability in Shanghai (Golait *et al.*, 2009; Zhixin *et al.*, 2009). Furthermore, Golait *et al.* (2009) comments that sustainable development demands a sustainable supply of energy resources that is readily available in the long term, at a reasonable cost to the country and concludes that wind power is the best technological choice for achieving a sustainable energy future (Midilli *et al.*, 2006). There are however, numerous advantages to the development of renewable energy sources with regard to an increase in job creations, advanced research and development, less environmental impacts and an increase in technological innovations (Midilli *et al.*, 2006). The transition to a low-carbon economy will require technological solutions, such as the development of renewable energy to address the impacts of global climate change.

Kumar *et al.* (2007) argue that the maximum use of renewable and alternative sources of energy is just one step in the direction to achieving a sustainable energy system (Schweizer-Ries, 2007). Carbon Capture and Sequestration (CCS) also provides a way to mitigate the emissions of CO_2 (Verbruggen, 2007). Gerard and Wilson (2008) comment that the technologies for capturing, transporting and injecting CO_2 from industrial facilities are generally well understood and is claimed to be achievable. Riahi *et al.* (2004) and Gerard and Wilson (2009) comment that the primary objective of CCS is to stabilise or reduce CO_2 emissions. However, there are concerns about the possibilities that the sequestered CO_2 could migrate or even escape to the surface and would undermine the efforts to reduce atmospheric CO_2 concentrations and would greatly affect the global environment (Gerard and Wilson, 2009). Identifying the potential risks for CCS and developing mitigation strategies to prevent leakages will help to ensure the technology is efficient in its purpose (Gerard and Wilson, 2009). Moreover, Riahi *et al.* (2004) state that not

only will the combination of employing renewable energy sources and CCS will reduce CO_2 emissions, but it will also have positive social issues such as new jobs in research, development and maintenance will be created and given the state of the global economy, this may prove to be a viable technological solution (BBC News, 2008). In order to develop the revolutionary technologies that Pacala and Socolow (2004) argue are required for substantial emissions reductions, particularly in the second half of this century, advanced research and development would need to commence immediately. BBC News (2009b) supports this claim regarding revolutionary technologies particularly where renewable energy technologies are concerned. Research and initial development of experimental devices designed to harness the power of the tides and waves have been deployed in the turbulent waters off the coast Orkney, north of Scotland (BBC News, 2009b). The experimental devices that are currently being developed and tested have huge potential, particularly to develop such new, revolutionary technologies on a bigger scale to produce sustainable energy. However, investment is required to ensure that revolutionary technical projects do not fail and contribute towards producing sustainable energy that will reduce the reliance on carbon intensive sources of energy (Hoffert *et al.*, 2002; BBC News, 2009b). In addition, there are numerous environmental and economic advantages that are available with the development of revolutionary renewable energy technologies such as exploiting huge amounts of wave and tidal energy and commercial benefits by selling the technology overseas. As an island, Britain should be in an ideal position to pioneer sustainable marine energy and effectively combat climate change (BBC News, 2009b).

What role can technology play in addressing climate change?

Schweizer-Ries (2007) argues that often, energy sustainability is often reduced to a purely technical problem and that renewable and alternative sources of energy along with energy efficient technologies are developed to solve the problem. However, it is the consumer, from all levels of society who decides how much and what kind of energy they consume. There is no single obvious solution to climate change however; both mitigative and adaptive strategies as well as technical and social strategies must be employed by governments, industries and communities across all scales, in order to mitigate the severe impacts of climate change (Omer, 2008a). It is beyond the scope of this paper to define what technology is 'good' and 'bad' technology however, as Schweizer-Ries (2007) argues society, societal needs and growth are the driving forces behind the technology and are the ones determining its use, and therefore this delivers the outcomes of using that technology. However, technology can be perceived as the 'wrong way' to approach and achieve a sustainable future, particularly if certain technology is used incorrectly then disastrous or catastrophic effects could result. Verbruggen (2008) argues that along with renewable energy, nuclear power also is another main option as a suitable couple to address human-induced climate change. Concern at the potentially huge damaging effects of an accident at a nuclear power facility, which has long lasting effects, is one of the major issues along with the proliferation of nuclear knowledge and weaponry and also nuclear waste disposal into the environment which hinders nuclear power constructions such as accidents at Chernobyl, Ukraine and Three Mile Island, USA (Middleton, 2003; Verbruggen, 2007). Giddens (1991: 4) states that

> "...so long as science and technology continue to be involved with the creation of novel weaponry, the risk of massively destructive warfare will persist".

Research into future alternative routes to combat the complex issues of the present time such as rising energy demand and climate change is being conducted and that technological solutions are expected to play a key role (Omer, 2008b). In general, Obijiofor (2009) states that new technologies are perceived as major tools for reviving ailing

economies and for assisting developing societies to transform their economies in order to overcome the issues of poverty and illiteracy to improve quality of life and combat human-induced climate change (Omer, 2008a). Moreover, development and economic growth are more reliably dependent on the application of new science and technology (Kajikawa *et al.*, 2008; Li *et al.*, 2008). However, there are preferences from various sectors to prefer outdated technological solutions which could hinder progress towards addressing climate change (Riahi *et al.*, 2004; Gore, 2006). Schweizer-Ries (2007) comments that there are many aspects that can affect the role of technological development in achieving a sustainable future in relation global climate change such as politics, the economy, the environment and society which can have both positive and negative effects. Furthermore, Schweizer-Ries (2007) argues that technological development should not be seen as independent from people. Instead, it should be understood as a socio-technical approach in which technological development and humans are influencing one another and developing in co-operation (Healy, 1995).

The role of the 2009 Copenhagen Conference

The United Nations Climate Change Conference (COP-15) took place in Copenhagen from the 7th – 18th December 2009 to set the details on the action necessary to reduce the rate at which the earth's atmospheric temperature is increasing. COP-15 refers to the 15th Conference of the Parties to the United Nations Framework Convention of Climate Change (UNFCCC). Political, public and scientific consensus has emerged that drastic reduction of global GHG emissions will need to be rapidly implemented in order to combat global climate change and its negative consequences (Moriarty and Honnery, 2008). For the past decade, actions to reduce carbon emissions and global atmospheric temperatures have centred on the Kyoto Protocol, which is set to expire in December 2012. The main purpose of the Copenhagen conference was to establish a new legally binding agreement that will be considerably stronger than the Kyoto Protocol, which received strong criticisms from climate scientists stating that Kyoto did not go far enough to curb increasing GHG emissions (Prins and Raynor, 2007; COP-15 Copenhagen, 2009a). The Kyoto Protocol is considered to have failed in its approach towards significantly reducing GHG emissions whilst ignoring the difficulties of developing countries struggling to mitigate and adapt towards human-induced climate change and cope with climate change related disasters (Prins and Raynor, 2007). The primary aim of the Copenhagen conference was to set out details regarding reductions in CO_2 and GHG emissions from developed and developing countries whilst establishing an annual fund to assist developing nations effectively address, mitigate and adapt to climate change (COP-15 Copenhagen, 2009a). Finance was one of the key issues that was thoroughly debated at the conference with developing nations demanding significant amounts of money to reduce their emissions and developed countries reluctant to supply it, particularly following the global economic downturn. Inevitably, significant amounts of this money that will be put forward will go towards the development of mitigation technologies such as renewable energy sources, CCS and energy efficiency measures. An agreement known as the 'Copenhagen Accord' was formally recognised but not formally adopted by the Conference of the Parties to the UNFCCC (COP-15 Copenhagen, 2009b). Although the accord is not a legally binding agreement as intended nor does it give in-depth details of how to achieve significant reductions of emissions, it is seen as a significant first step of a process that will lead towards a legally binding treaty in 2010 (COP-15 Copenhagen, 2009c).

The Copenhagen Accord recognises the need to limit global temperatures by 2 degrees above preindustrial levels, above which is considered dangerous climate change but does not formally endorse this agreement. Following two years of preparations and negotiations since the UNFCCC Conference in Bali 2007 and two weeks of talks at

Copenhagen, the accord does not state a year for GHG emissions to peak and a collective target for emission reductions. Earlier drafts of an agreement included an aggregate target of emissions reduction of 50% by 2050 however, no formal target for global GHG emissions have been adopted within the Copenhagen Accord. As it stands, emission reduction targets are yet to be announced and they may be at a lower level of what was initially declared. The accord does not highlight how emission reductions will be achieved to keep global emissions within a scope of control. A review of the accord will be completed by 2015 as considerations of the pledges given by both developed and developing nations may be found to be insufficient to appropriately combat climate change (COP-15 Copenhagen, 2009c). This review would also include a consideration of the aim to limit the global temperature increase to 1.5 degrees, an increase that is supported by Small Island Developing States. The accord also promises to deliver $30bn of aid for developing countries over the next three years and outlines a goal of providing $100bn a year by 2020 to assist developing countries address the impacts of climate change (BBC News, 2009c). The Copenhagen conference can be considered a success and a failure, although an accord has been reached and seen as a significant first step towards a treaty, the conference itself has failed to deliver on its objectives which has resulted in massive differences between its aims and outcomes. The challenge for achieving significant emission reductions remains with turning the Copenhagen Accord into a measurable, legally binding treaty that will effectively address global climate change. The Copenhagen Conference in December 2009 was seen as a starting point for a new, low-carbon economy and technological revolution that will significantly contribute towards addressing the threat of climate change. The international community can only be fully successful in addressing climate change if it is able to develop and utilize environmentally sustainable technologies that will support mitigation and adaptation efforts. The next round of negotiations takes place in Bonn, Germany on 31st May 2010 for two weeks which precedes the next annual UNFCCC Conference scheduled to take place in Mexico City at the end of 2010 (COP-15 Copenhagen, 2009c).

Conclusion

Although the use of old technology is considered to have caused the issue of climate change (Gore, 2006), it is widely perceived that scientific progress with new technology is the best way forward towards addressing climate change. Furthermore, with respect to achieving a sustainable future, the role of technological solutions is contested but shall play a pivotal role towards any transition towards sustainability (Healy, 1995), however, it is society that develops and ultimately determines the application of technology and as a result, in terms of the decisions made, will influence whether or not technology can contribute towards a sustainable future (Schweizer-Ries, 2007; Omer, 2008b). Technological development has provided an infrastructure for society and our quality of life and is woven into the fabric of everyday life (Obijiofor, 2009). This paper has looked at sustainable environmental futures with particular reference to energy sources, sustainability and climate change and concludes that technology can be part of the problem and also part of the solution. To combat anthropogenic climate change a number of technical strategies need to be employed such as renewable energy technologies and CCS (Riahi *et al.*, 2004; Gerard and Wilson, 2009; Golait *et al.*, 2009). Golait *et al.* (2009) state that renewable energy sources globally, are in abundance, which can fulfil growing energy demands and can achieve a sustainable energy future (Midilli *et al.*, 2006). It is important to acknowledge that technological development should not be seen as independent from people and should be understood as a socio-technical approach in which technological development and humans are influencing one another and developing in co-operation (Healy, 1995; Schweizer-Ries, 2007).

With particular reference to global climate change, technological solutions will play a

vital role in combating its negative consequences. However, the role of social solutions should not be ignored and substituted in favour of technological solutions to achieving sustainability and addressing global climate change. Society already possesses the mitigation technologies to bring about substantial emission reductions necessary to freeze CO_2 and GHG emissions for the next half-century (Pacala and Socolow, 2004). Although a legally binding agreement from the Copenhagen conference was not achieved, the 'Copenhagen Accord' promises to deliver substantial financial aid to assist developing countries address the impacts of climate change (BBC News, 2009c). A legally binding treaty that will effectively address climate change is required that states sufficient emission reduction targets that will prevent potentially dangerous and irreparable climate change. With reference to technological solutions, the accord does not mention the role of technology however, it is expected that the global annual fund will contribute to the development of mitigation technologies and technology transfer. Ultimately, technological solutions will play a major role in addressing climate change and green growth will become the dominant economic model however, significant investments are required to allow research and development at an industrial scale to effectively address, mitigate and adapt towards global climate change (Pacala and Socolow, 2004; BBC News, 2009b).

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