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The Narrow Pathway to A Sustainable Energy System

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Abstract

Achieving a sustainable energy system is a wide and complex area of debate and is also one of the most crucial issues facing the modern world. Despite all the environmental concerns associated with its generation and consumption, its use, from very basic human activities such as making a cup of tea to the most complex industrial processes, is unavoidable and will continue to be at the heart of the many challenges that arise globally. A sustainable energy system can be summarized as a system that provides access to affordable energy, ensures that the supply is secure, while minimizing the associated environmental impacts. This article, written mainly from the UK/ EU perspective, attempts to provide a brief overview of the current challenges and mitigation measures and targets as well as focusing on the EU Emissions Trading System, which is one of the key elements in the discussion, imposing cost as a driver.

Keywords: *Energy, Energy Efficiency, Environment, EU Emissions Trading System, Sustainability, Green House Gases.*

Introduction

The modern world has been witnessing increasingly significant challenges in terms of achieving a sustainable global energy system globally. (Department of Environment, Food and Rural Affairs (GB DEFRA) (2005, p.7) defines sustainable development as "*The goal of sustainable development is to enable all people throughout the world to satisfy their basic*

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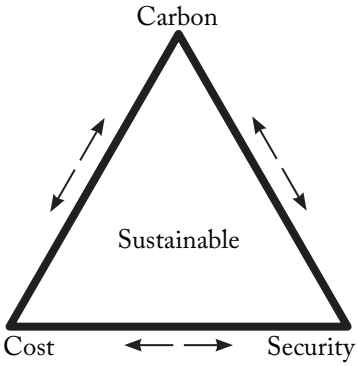
needs and enjoy a better quality of life without compromising the quality of life of future generations". In addition to this, and also so as to relate the question of sustainability to the energy system, the energy trilemma Fig. 1, which was first described by E.ON (2008), illustrates the main challenges of Energy Security, Cost/Social Equity and Carbon/Environmental impact in order to achieve a sustainable Energy System, Boston (2012). Basically, all three key aspects of the trilemma should be satisfied and taken into consideration in order to secure an energy supply to meet current and future demand for both home and industrial users, ensuring that supply is accessible and affordable while addressing the related climate change and environmental issues that might arise.

Figure 1. The Energy Trilemma



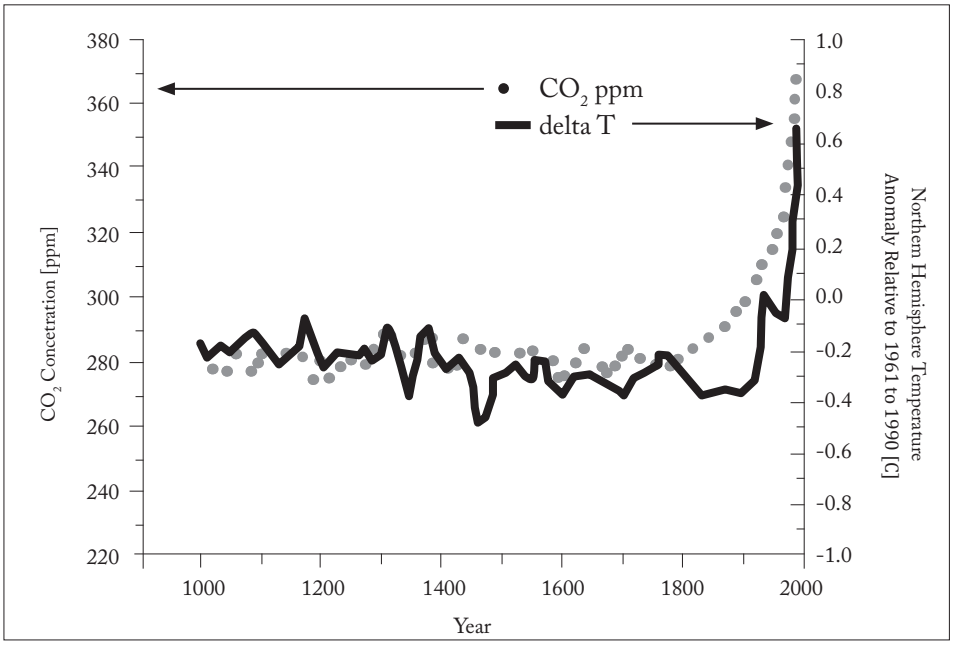
Source: E.ON (2008)

In order to effectively tackle these complex challenges and also to meet the climate change targets in particular, the current and future demand for energy should be first reduced through the best practice energy management techniques and then the "corrected" demand should be met by renewable and low carbon technologies utilizing nuclear and fossil fuel (using carbon capture and storage technology) sources so as to ensure that supply is secure for the base load in the short and medium term. In terms of promoting efficiency measures, reducing Green House Gases (GHG) emissions and making low carbon and green technologies more economically feasible, the EU Emissions Trading System (EU ETS) will also be discussed as it has a key role to play, in spite of significant concerns associated with it.

Environmental Impacts and the Mitigation Targets

World Energy Council (WEC) (1993) argues that the major responsibility for the emissions of greenhouse gases (GHG) may be strongly attached to fossil fuel combustion as scientific understanding on the elements that cause climate change continuously grows. It was also suggested by Elliot (2003) that there was possibly a link between increasing amounts of carbon emissions from fossil fuel combustion and the rise of carbon dioxide concentration in the atmosphere as well as continuously rising global average surface temperatures. Also to support this argument, Ghoniem (2011) demonstrated the relationship between CO2 concentration in the atmosphere and global average temperatures over the past 1000 years and it is evident that the rise of temperature follows the increase in atmospheric concentration. The graph below illustrates the rises in CO2 concentrations and global temperature with particular reference to the past 100 years, Fig. 2.

Figure 2. The rise in atmospheric concentration of CO2 and global average temperature over the past 1000 years



Source: Ghoniem (2011)

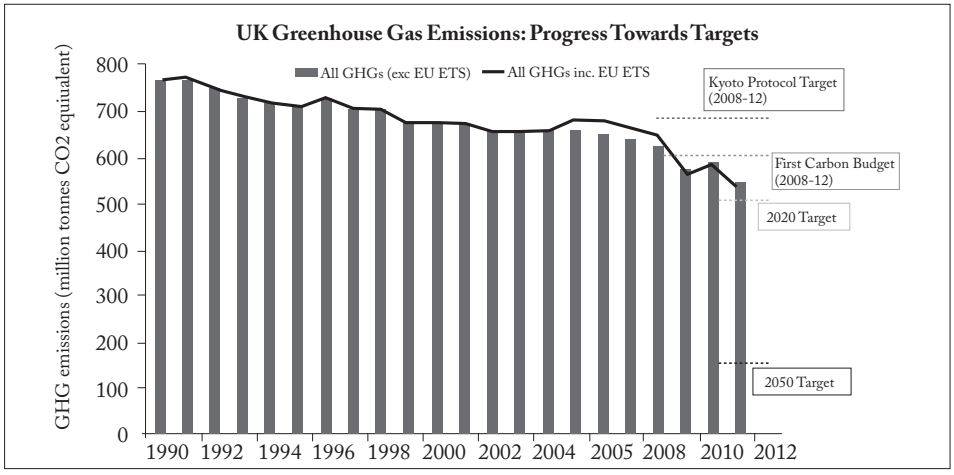
As a result of these concerns, there are now legally binding and ambitious emissions targets set by the UK and international organizations such as the European Union and the United Nations. The UK Climate Change Act 2008 which targets at least 80% cuts in emissions compared to 1990 levels through 5-year carbon budgets, four of which have been set in law up to 2027 and are now legally binding. Table 1 below shows the target reduction in emissions on a phased basis with regard to each carbon budget that has been issued to date. Also to demonstrate the progress of the UK that has been made up to the year 2011, Great Britain Department of Energy and Climate Change (GB DECC) (2012) has issued the chart illustrated below (Fig. 3), which shows the performance against the targets using provisional figures for the year 2011.

Table 1. UK Emission reduction targets for the budgets 1-4 up to 2027

	First carbon budget (2008-12)	Second carbon budget (2013-17)	Third carbon budget (2018-22)	Fourth carbon budget (2023-27)
Carbon budget level (million tonnes carbon dioxide equlvalent ($MtCO_2e$)	3,018	2.782	2,544	1,950
Percentage reduction below base year levels	23%	29%	35%	50%

Source: GB DECC (2011)

Figure 3. UK green house emissions: progress towards targets



Source: GB DECC (2012).

The UN Kyoto Protocol 1997, the first international treaty in this regard, set out a reduction of 5.2% below 1990 levels between 2008 and 2012 for the countries that agreed to it. In addition to this, the other international legally binding targets are set out by The EU Climate Change and Energy Package European Commission (EC) (2012a), includes what are also referred to by the European Commission as "20-20-20" targets and introduces 3 main objectives for 2020:

- A 20% reduction in EU greenhouse gas emissions from 1990 levels;
- A rise in the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency.

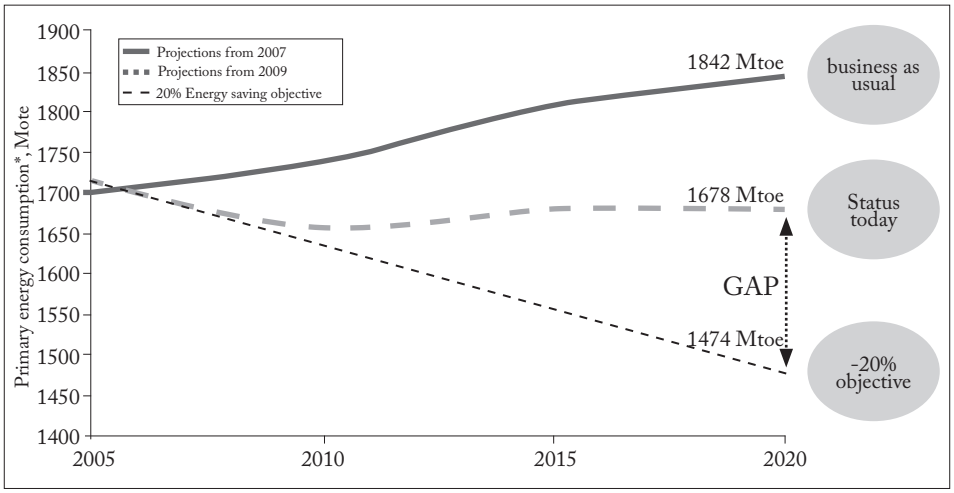
Demand Reduction through Efficiency and Energy Management

Reducing the demand for energy by increasing efficiency and encouraging savings will not only contribute to achieving those ambitious targets but also enable policy makers to develop more accurate projections with regard to the future demand for energy. It was also suggested in "The New Policies Scenario" by the International Energy Agency (IEA) (2011), International Energy Agency, that the reduction of the demand due to improved efficiency, in other words, the energy that is not consumed, represented the most important factor contributing to meeting energy security and climate change targets in the scenario.

The target of a 20% improvement in the EU energy efficiency, which is one of the 20-20-20 targets is very unlikely to be achieved Fig. 4. The graph suggests that the primary energy consumption projection from 2009 up to 2020 is significantly higher than the EU 2020 objective of a 20% reduction. In terms of the GHG emissions, the European Environment Agency (EEA) (2012) report suggests a sudden drop in 2008, however the immediately following trend for 2009/2010 is upwards and indicates that it will be a real challenge to meet the 2020 target of 20% reduction, compared to the 1990 baseline level, Fig.5. A study by Ecofys and Fraunhofer Institute (2010) estimated that the gap in 2020 would be 208 Mtoe (million tonnes of oil equivalent) compared to the EU target for primary energy consumption and argued that in order for the EU to achieve this target by 2020, the effects of energy policies needed to be tripled. Regarded by the EC (2012b) as a move in the right direction, the European Parliament (EP) voted in favour of the Energy Efficiency Directive (EED) on 11 September 2012 which is now legally binding on all member states to use energy more efficiently including its generation, distribution and final consumption.

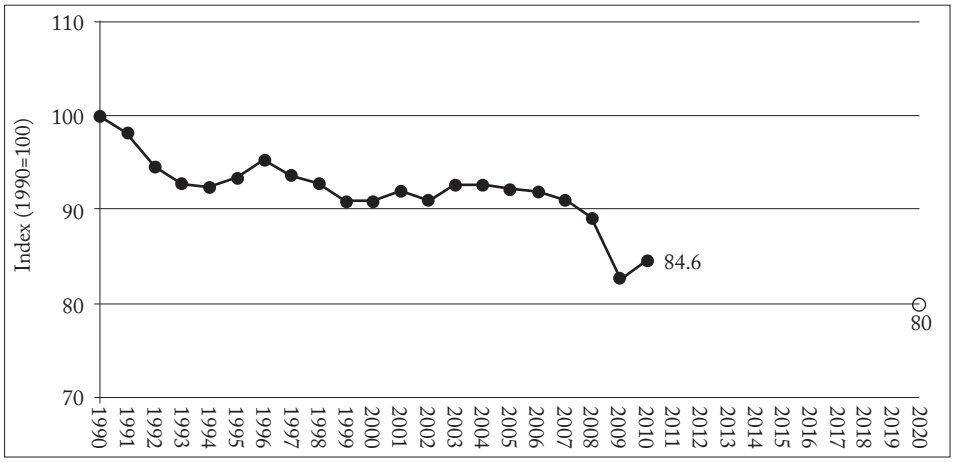
In addition to this, at the UK level, it is hoped that the "Green Deal" regulations established in 2012 will enable homes and businesses to install some energy-efficiency measures in the buildings without having to pay upfront costs by making repayments through electricity bills. The scheme is to be rendered effective from January 2013 and is also funded by energy suppliers as part of the "Energy Company Obligation".

Figure 4. Primary Energy Consumptions Projections to EU 2020 Targets



Source: EC (2011)

Figure 5. EU-27 GHG Emissions 1990-2010 (Excluding Land Use, Land Use Change and Forestry)



Source: EEA (2012)

Concerning the importance of energy management, Backlund et al. (2012) argue that inclusion of energy management in future energy policies will significantly contribute to the chance of achieving not only the EU 2020 targets but also those of later periods up to 2050. In this regard, the new ISO 50001:2011 Energy Management Standard which replaced the EN 16001:2009 is expected to play a key role in order to promote exercising of the best energy management practices worldwide by providing organizations with a comprehensive framework of the requirements.

Further Actions to Meet the Targets – The EU Emissions Trading System and Concerns

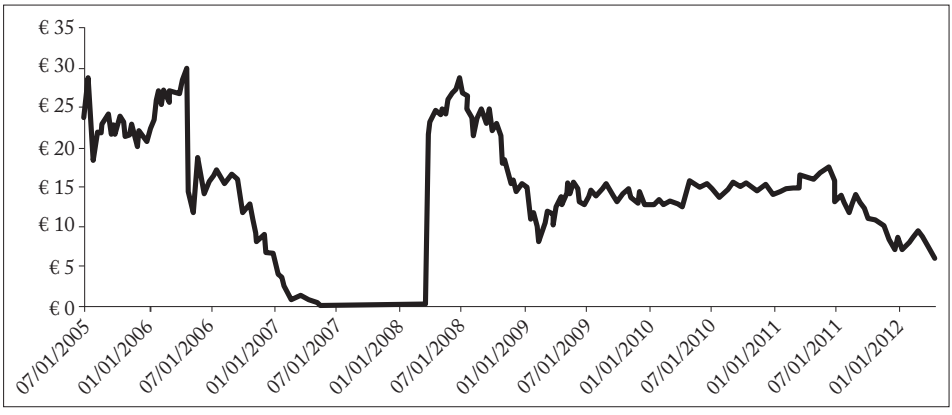
Yet another initiative in order to achieve the EU 2020 targets, also as part of the EU Climate and energy package, the reform of the current EU Emissions Trading System (EU ETS) is a major piece of complimentary legislation, which underpins the Emissions Trading Directive. According to Skjærseth and Wettestad (2010), the system aims to establish a low carbon energy economy based on imposed emission limits, renewable energy generation, increased energy efficiency and innovative technologies that aim to put the EU on track to meet its ambitious environmental targets. Covering some 11,000 power stations and industrial plants in 30 countries, EU ETS is the first and biggest scheme for trading GHG allowances internationally. The basic principle of the system is to cap and trade the emissions by which companies can receive allocated emission allowances that they can sell to or buy from other companies within the system or keep the surplus amount for their future needs. The other fundamental element of the scheme is the limit on the allowances to ensure that they have a market value for trading. As outlined by EC (2012c), these limits will be ambitiously reduced over time, such as the available allowances by 2020 which will be 21% lower compared to 2005.

Following the first two phases of he EU ETS, the scheme is now due to enter its third phase from 2013 with some significant changes such as the phasing out of free allocation of the allowances and the gradual replacement of this system with auctioning, which starts initially with the implementation of electricity generators. As Clò (2010) summarizes, the new ETS Directive was approved in December 2008 developed on the basis that, 80% of initial allowances will be allocated freely in 2013 and after that, free assigned allowances will be reduced by an equal amount every year, resulting in a situation in which only 30% of the overall allowances will be

freely assigned by 2020 and full auctioning only becomes the rule by 2027. Since the start of 2012, the aviation companies that serve the airports in the EU area were also included in the system, and from 2013, the system is to expand covering (N2O) emissions from nitric, adipic and glyocalic acid production and perfluorocarbons from the aluminium sector. The cap for 2013 has been determined by EC (2012d, 2012e) to be slightly less than 2.04 billion EUAs (European Union Allowances, 1 EUA represents the right to emit 1 ton of CO_2). In addition to this, as a sign of the possible global roll-out of the scheme, Australia will be able to purchase allowances from the system from July 2015 and will also be in a position to trade its allowances with the EU no later than July 2018. It is also known that there are plans at various stages for similar trading systems in China, California and Korea (Chemical Week, 2012). These are positive signs for the EU ETS in terms of a possibility for a global roll-out of the system.

In terms of maintaining stable market conditions within the system, there have been major issues with the volatility of the carbon price in the past. Fig. 6 below shows the volatility of the carbon prices traded within the EU ETS during the phases 1 and 2 since 2005. According to Venmans (2012), carbon prices crashed in 2006 and fell further in 2007 during the first phase due to National Allocation Plan (NAP) through which the member states determined the free allocations to each plant within the countries according to national criteria, which eventually led to allocations exceeding the verified emissions each year and consequently led to a price crunch. Following the first-pilot phase, prices decreased significantly again in 2009 in the second phase mainly due to the financial crisis that emerged in 2008.

Figure 6. Evolution of carbon price



Source: Venmans (2012)

There are currently significant concerns over the new scheme that will progressively reduce allowances further and potentially result in competitiveness issues for European businesses. The OECD (2006) defines the risk of this situation as "carbon leakage", which stresses the risk of businesses having to displace and relocate their carbon intensive productions to unregulated countries/regions. Unlike the energy sector, which remains virtually unexposed to international competition, the carbon leakage issue directly threatens other energy intensive sectors such as manufacturing. Clò (2010) argues that, as these businesses are being pushed into a difficult position in which increased cost of production due to the cap on emissions is passed onto the final product price thus resulting in the significant loss of market share against their non-EU competitors, the industries concerned may be forced to relocate their production and investments to non-EU countries, as industrial lobbies claim.

In addition to this, Antimiani et al. (2012) suggest that another type of leakage could also become a concern as the decrease in carbon-energy demand in abating countries may consequently result in energy prices to fall internationally. According to Reyer and Onno (2007), as a result of this potential decrease in carbon-energy prices, in non-abating countries where carbon-energy is substituting for other inputs, demand for carbon-energy would likely increase and this situation is referred to as the Energy Market Model. It is evident that should such a scenario become a wide reality, all the efforts to reduce carbon emissions within the EU might become ineffective, as the increasing demand for carbon-energy and resulting higher emissions in the non-abating parts of the world would continue to worsen the situation of climate change, which is a global issue and requires collective action.

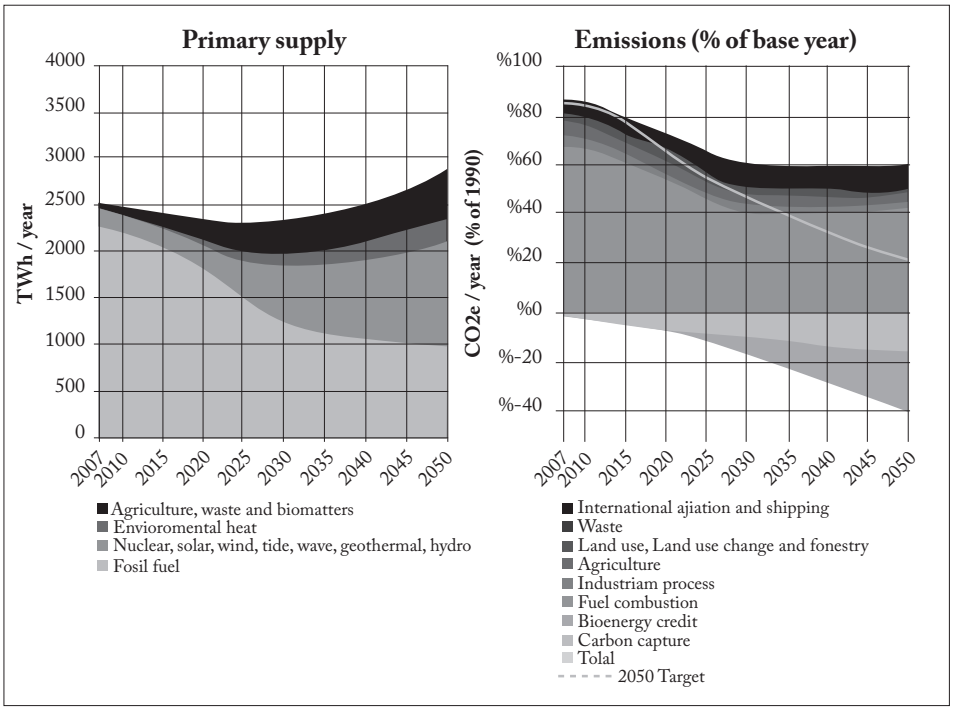
The Way Forward and Conclusions

Encouraging energy efficiency and savings and reducing demand through effective energy management practices appear to be the key issues to be taken into account when developing policies as this will provide great benefits with regard to all aspects (security, cost and environment) of the sustainable energy trilemma. Backlund et al. (2012) suggest that promoting investments in developing more energy-efficient technologies proves to be an important step in order to achieve ambitious energy- efficiency and climate targets. In addition to this, when discussing how to form the industrial energy systems in the future, energy management practices are to be considered at the heart of the solution. The way to improving energy efficiency in a cost-effective way is the combination of good energy management practices and investments in energy-efficient technologies.

The new (third) phase of the EU ETS is one of the key schemes that uses the cost as a driver and forces industries to invest more in energy efficiency measures and look for ways to utilize low carbon energy sources. However, since the major concerns such as competitiveness and carbon leakage that may hinder the achievement of the whole system to actually deliver the intended outcomes, a significant amount of effort that should be made to address. Supporting this point, given the fact that environmental impact and consequently climate change are global issues, the initiatives need to be developed and applied in a collective manner rather than only by a fraction of the world in isolation. The WEC (1993, p.35), the World Energy Council, describes the challenge of achieving global sustainable development as:

> "*... the utmost importance to address these widely different concerns in a realistic and balanced manner to reduce – as far as possible – the associated stresses between countries and regions. Without sufficient attention to this dimension of the world energy problem, there will not be sustainable development consistent with the expected population explosion in the developing world*".

Figure 7. 2050 Pathway Analysis, Pathway Alpha



Source: GB DECC (2010)

Achieving the goal of a sustainable energy system globally will be the practical result of the efforts of individual countries in developing strategies and national energy policies that should be in line with global targets and consensuses. As a good example of solutions on a national scale, the 2050 Pathway Analysis Report by GB. DECC (2010) studied a number of scenarios and one of which, the Pathway Alpha above Fig. 7, shows how it can be made possible to meet the projected demand in an environment-friendly way, also by utilizing measures with regard to efficiency increases and demand reduction and achieve both national and EU emissions targets by 2050. It can be seen that the supply side is well structured by progressively increasing the share of low carbon (nuclear in particular) and renewable technologies and also by deploying CCS (Carbon Capture and Storage) technology for fossil fuel powered plants, while reducing the use of fossil fuels progressively so as to ensure that the supply for base load is secured going forward into the future.

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