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CARBON FOOTPRINT REDUCTION STRATEGIES FOR DIFFERENT SECTORS OF THE ECONOMY

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ABSTRACT: *Climate change is one of the greatest challenges facing mankind. Carbon dioxide, Methane and other greenhouse gases are responsible for climate change which results in global warming. It is estimated that about 37 billion tonnes of carbon dioxides are produced every year from the burning of fossil fuel alone whilst about 7 billion tonnes are produced from deforestation. If the emission of greenhouse gases continues unabated due to anthropogenic activities, the average global temperature will also continues to increase and eventually results to severe weather disruption, rise in sea levels and changes in land use patterns.Hence, this paper aims to highlights the various strategies that could be adopted in a bid to reduce global carbon footprint from anthropogenic activities. The paper employed the use of journals and other scholarly publications to provide insight into possible techniques that could be used in the transportation, manufacturing and housing sector. The paper found that adequate house insulations, low carbon vehicles, renewable energy projects such as small wind turbines, solar water heating system and biomass energy plant are possible steps that could be taken to reduce the carbon footprints of various sectors.*

KEYWORDS; climate change, global warming, carbon footprint

INTRODUCTION

Climate change is one of the biggest challenges facing humanity. According to (Kachel and Jennings, 2010) climate change is one of the major threats to modern day society. Wright et al (2013) added that the "emergence of increasing global average temperatures and the escalating extreme weather occurrence highlight the existential challenges that climate change poses to humanity". Furthermore, Wright and others argues that from the various predictions, increases in world average temperature are expected in the nearest future. Hence, Hardoy and Pandiella, (2009) pointed out that, climate change is often associated with unusual and extraordinary weather condition such as floods, droughts, extreme temperatures, heavy rains and storms.

According to(Adger et al., 2003) the IPCC affirmed that there is little doubt that human-induced climate change is happening. Bele et al.,(2014)added that the effect of climate change is already having a significant impacts on the ecosystems, many economies, and communities. Hence, nations of the world must develop programs aimed at coping with the changes that are predicted — warmer temperatures, drier soils, changes in weather extremes and rising sea levels. Alongside other effects such as coastal erosion from higher storm tides and increasing storm intensity and flooding (Hayward, 2008). In addition, other adverse impacts such as heavy rainfall, inconsistency in seasons and increase in the frequency and severity of weather events (Supharatid, 2015).

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Apart from weather conditions, Maddison, (2001) argued that climate change can have tremendous effects on the economies of many countries. Maddison pointed out that tourisms and organised holiday trips are now a way of life to members of the public. His view is that, for many people the choice of a holiday destination may vary from; interest in foreign culture, landscapes, security and political stability of a country. Nevertheless, Heargues that the climatic condition of a country is one of the major factors that determines holiday destination for many people. Therefore, any alteration in the climatic condition of a place is likely to major consequences for tourism dependent economies.

Bele et.al (2014) argues that although, almost all nations will be affected by climate change. People from developing countries are likely going to be most affected as a result of the high level of poverty in many developing nations. In addition, the lack of attention particularly from the political class to the risks faced by a large sections of the urban population from extreme weather puts many people at high risk from the likely impacts of climate change in most of these countries"(Hardoy and Pandiella, 2009). Furthermore, Bele et al., (2014) argues that, apart from poverty, another factor that makes developing countries more vulnerable to climate change is the fact that a significant percentage of the population depends on climate-sensitive resources for their survival. Therefore, as the availability of natural resources reduces, so does the viability and security of the livelihoods of those who depends on it. In addition, Hardoy and Pandiella, (2009) also added that corruption and the lack of proper developmental planning further exacerbate the problem of climate change in developing countries.

According to Richard (2009) gases such as methane and $CO_2$and other gases commonly referred to as green house gases are responsible for climate change. However, the emissions of these gases are essential in many natural processes. Richard pointed out thatmost household, farm and company emits greenhouse gases (GHG). He added that, some agricultural products such dairy, rice, beef and mutton cannot be obtained without the emissions of greenhouse gases. Similarly, cheap energy from fossil fuel cannot be obtained with some level of greenhouse gas emissions. Hence, Richard concluded that climate change is more uncertain and complex than any other environmental hazard. Weather for instance affects health, energy use, agriculture and other aspect of nature. The figure below shows the distribution of greenhouse gas in earth's atmosphere. Carbon dioxide is clearly one of the major (76%) causes of climate change.

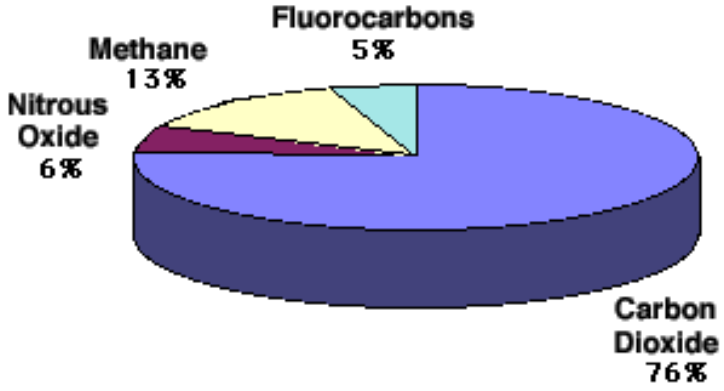

Fig 1: percentages of GHG in the atmosphere (Source: Hopwood and Cohen, 1998).

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Ramanathan and Feng, (2009) reported that the emission of greenhouses gases such as (NO_x, CO and others) results in the warming of surface temperature with some significant implications for rainfall, retreat of glaciers and sea ice, sea level, among other factors. In recent decades, according to a report (European Commission, 2007) the area of Arctic ice at the North Pole has reduced significantly by about 10% and the thickness of the ice above the water has decreased by about 40%. The report added that, a large part of the glaciers in the Swiss Alps will cease to exist by 2050. The report went on to say that, the continuous rise in sea level as a result of climate change and the increasing temperature will likely result in a reduction of biodiversity as some plants and animals species such as polar bears, penguins among others may not adapt easily to changes in temperature.Likewise, a report by Wang and Chameides (2005) argues that recent events such as the heat waves in Europe which resulted to the death of about 27,000 people; the torrential rainfall of 1999 in Venezuela which cost about 30,000 lives and the severe drought in western part of United States in 2004, all points to the fact that global warming is already happening.

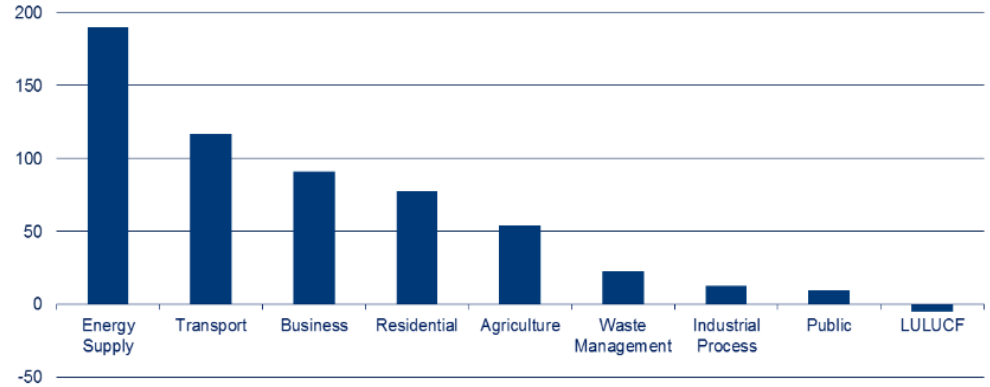

Fig 2; GHG by sector, UK. Source; Department of Energy & Climate Change, (2015)

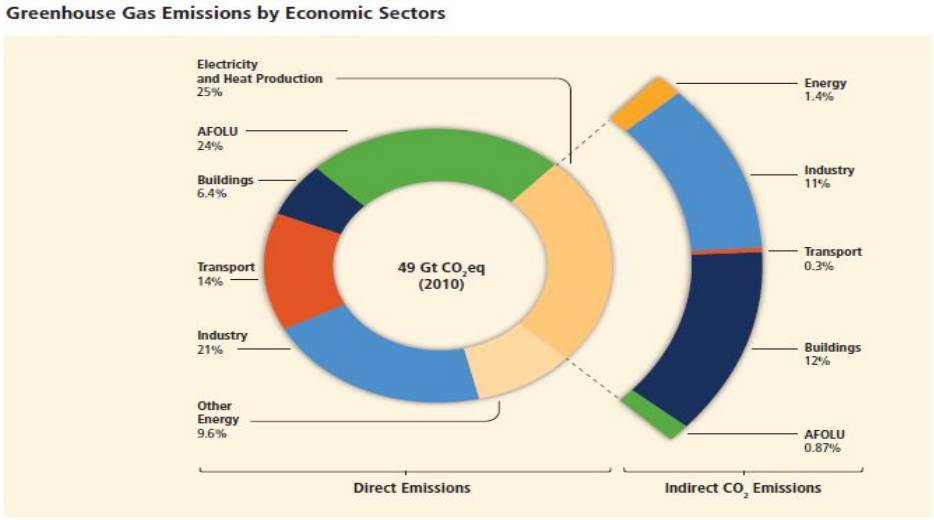

Fig 3; GHG by Economic Sector; IPPC (2014)

It is therefore necessary to examine some of the main sources of greenhouse gases and steps that could be taken to reduce anthropogenic sources of greenhouse gases. Hence, this paper briefly reviews some key steps that could be taken in order to reduce global carbon footprint

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from specific sectors such as the transportation sector, housing amongst others. From figure 2, it is clear that energy supply and transportation are some of the major sectors which contribute significantly to greenhouse gases in the UK. Land Use, Land-Use Change and Forestry (LULUCF) contribute the least amount of greenhouse gases to the atmosphere. While waste management, residential, agriculture and the commercial sector play a significant role in the overall contribution of the UK's greenhouse gas emission. Similarly, figure 3 shows that on a global level, electricity and heat generation processes produce the highest level of greenhouse gases. Agriculture, Forestry and Other Land Use (AFOLU) and other sectors such as the industrial, transportation and other energy processes contributes significantly to global greenhouse gas emission.

Carbon Footprint

In the last few decades, the term carbon footprint has gained prominence in almost every sphere of life. The term has featured predominantly in international politics and policies of many countries, in the media and in academics amongst other sectors. Several voluntary schemes such as the carbon disclosure project now exist to report the carbon footprint of products, businesses, organisations and processes. According to (The Carbon Trust, 2010) the essence of capturing carbon footprint data is to reduce or manage greenhouse gas emission. In addition to reducing the greenhouse gas emission of organisations, processes or products carbon footprint data also enables the reporting of footprint to a third party in order to meet mandatory reporting requirements of climate change legislation; for example, the EU emission trading scheme or carbon reduction commitment or even for marketing purposes.

According to (Wiedmann and Minx, 2007) carbon footprint is a popular concept used in discussions seeking to proffer solution to the impact of climate change. They further argued that, the term has become a buzzword used in and by the government, media houses and in the business community. Gupta, (2014) argued that in recent time carbon footprint is now a synonym for the impact of climate change from communities, individuals and any specific area of interest. According to (The Carbon Trust, 2010) carbon footprint considers six of the Kyoto Protocol greenhouse gases, namely: Nitrous oxide, Carbon dioxide, Sulphur hexafluoride, Hydrofluorocarbons, Methane and Perfluorocarbons.

The meaning of carbon footprint can be adapted specifically to different sectors, activities or countries. In the UK for instance, A report by the Department of Environment, Food and Rural Affairs, (2015) defined carbon footprint as emissions associated with the spending of UK consumers on services or goods even if the emissions arose from the other countries during the supply chain of the goods or services, in addition to emissions generated from UK transportation and domestic activities. Likewise, Madin and Macreadie, (2015) defined the carbon footprint of seafood products as the volume of greenhouse gas emissions emitted during the production, transportation and consumption of sea food products. Despite the fact that carbon footprint can be defined to meet the specific needs of various sectors. Wiedmann and Minx (2007) argued that one common agreement on carbon footprint is that the term represents the volume of gaseous emissions associated with climate change from human consumption or production processes. Nevertheless, Wiedmann and Minx (2007) defined carbon footprint as a measure of the total quantity of CO_2 emissions that is caused indirectly or directly by a process or is accumulated throughout the lifecycle of a product.

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Two common types of carbon footprint include; organizational and product carbon footprint. The organizational carbon footprints are the all greenhouse gases emission from energy use, buildings' industrial processes and company vehicles of an organisation. Whilst product carbon footprints are the greenhouse gas emissions produced through the life cycle of a product. This includes from extraction of raw materials and manufacturing to its final use, reuse, recycling and disposal (The Carbon Trust, 2010).

Generally most human activities generate greenhouse gases. For instance, Hertwich and Peters, (2009) pointed out that production processes contribute significantly to anthropogenic greenhouse gas emissions. They argued that although greenhouse gas emission from the transportation sector often focus more on emissions from the burning of fossil fuel. The production of vehicles also contributes significantly to greenhouse gases. For instance, they pointed out that in 2001 alone, about 800 million metric tons of carbon dioxide was emitted from the production of vehicles.

Table 1; GHG Emissions in 2004;

Total GHG Emissions in 2004 (excludes land use change, includes intl. bunkers) CO2			
Country	MtCO2	% of World Total	Tons CO2 Per Person
World	30,689.5	100.00%	4.8
Asia	10,388.7	33.85%	2.9
Europe	6,651.5	21.67%	9.2
North America	6,570.0	21.41%	20.2
Middle East & N. Africa	1,960.7	6.39%	4.5
South America	871.8	2.84%	2.4
Sub-Saharan Africa	676.2	2.20%	0.9
Central America & Caribbean	558.0	1.82%	3.2
Oceania	401.4	1.31%	12.6

Source; (European Parliament, 2008)

Table 1 reveals that carbon footprint of many developed countries is significantly high when compared to undeveloped countries of Africa and the Middle East. In table 1 for instance, in 2004 Asia and Europe were found to contribute about 55.52% of the total greenhouse gas emission for that year. This figure represents over a half of the entire greenhouse gases emitted in 2004. Whilst Oceania, Central America and Caribbean contributed about 5.33% of the total greenhouse gases for the year of interest. Globally, CO_2 is the most prevalentgreenhouse gas emitted by human activities. Several processes such as deforestation, the burning of fossil fuel and even biological processes from human as they exhale, it is estimated that human activities add about 30 billion tons of CO2 into the atmosphere yearly (Hopwood and Cohen, 1998).

METHODS OF CARBON FOOTPRINT REDUCTION

As pointed out by Wiedmann and Minx, (2007) debates on carbon footprint have not been exclusively limited to academics and scientist. Several private companies and NGO are also driving knowledge on the subject. One of such companies (Carbon Life Limited) gave a guide on carbon reduction strategies for organisations. These strategies are provided below;

Organisations seeking to reduce their carbon footprint should;

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✓ Examine their direct sources of emissions with a view to reducing their carbon footprint.
✓ Create bottom line savings by employing the use of technology to bring about cost effective energy efficiency measures.
✓ Reduce the carbon emission from their energy usage by the utilisation of alternative low-carbon energy sources especially from renewable energy technologies.
✓ The organizations should explore opportunities to reduce their indirect emissions by engaging or working withother organisations to develop strategies to reduce emissions and reduce costs up and down the supply chain(Carbon life, 2010).

Carbon footprint reduction strategy for household:
Carbon is emitted by household through the usage of energy such as electricity and gas. However, during the design and construction of houses, contractors can reduce household emissions through energy efficient design. In addition, the use of renewable and low-carbon energy sources by householders can also reduce their carbon footprint.The most cost-effective renewable energy source for household is a medium or large-scale wind turbine. Roof mounted photovoltaic panels and biomass heating are not cost effective choices. In the UK for instance, new housing developments are required to meet Part L regulations on energy efficiency. This regulation provides standards concerned with domestic energy usage for lighting, heating and hot water. Contractors and buildings are expected to meet the part L regulations in order to reduce the CO2 emissions of (Broer and Titheridge, 2010). The bulk of the average household's energy use goes towards water and space heating in the UK. Solar Water Heating is a renewable technology that can make dramatic financial and carbon emission savings. It offers a quicker payback (The Renewable Energy Centre, nd).

Several houses in the UK still do not have adequate insulation. For this reason, during the winter season a high consumption of energy is observed for such houses mainly due to space heating. In order to reduce the carbon footprint of household, the following insulations options could reduce energy usage and carbon footprint from households:

✓ Cavity walls: The cavity walls can easily get insulation blown in. Cavity wall insulation is injected into the cavity between the inner and outer leaves of brickwork that make up the external wall. It reduces heat loss through walls by up to two-thirds and reduces the heating bills by up to one third. (Borough Council of King's Lynn and West Norfolk, 2009)

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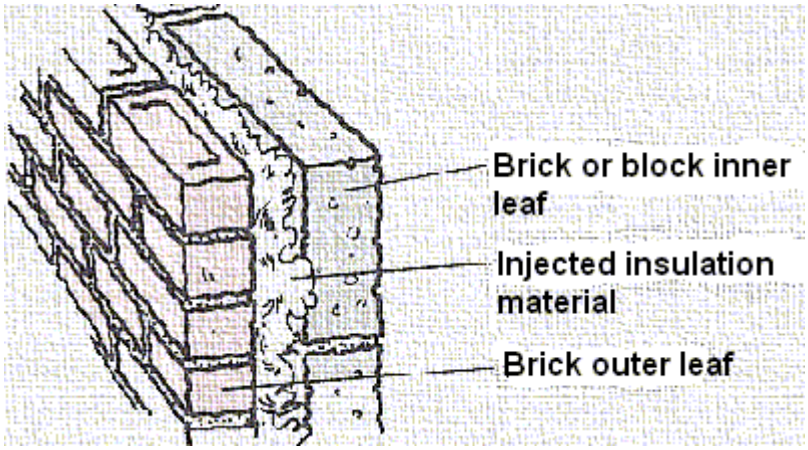

Fig 5: Cavity walls. (Source: Borough Council of King's Lynn&West Norfolk, 2009)

Table 2: CO2 savings of cavity wall insulations

Measure	Annual saving per year (£)	Installed cost (£)	Installed payback	CO_2 saving per year
Cavity wall insulation	Around £110	Around £250	Around 2 years	Ariound 560kg

(Source: Energy saving trust, 2010)

Table 2 shows that, cavity wall insulation saves around 560 kg CO_2 per year.

✓ Loft insulation: 20% of energy bill can be saved by effective loft insulation in a house. Loft insulation is the effective way to reduce heating bills, and the carbon footprint of a house. A depth of at least 150mm (6inches) is recommended for the loft insulation (DIYnot, 2010).

✓ Floor insulation: Floor insulation is easy to install and very effective to save heating bills. Timber floors can be insulated by lifting the floorboards and laying mineral wool insulation supported by netting between the joists. (Energy Saving Trust, 2010)

Carbon footprint reduction strategy for the Transportation sector:
A large volume of carbonsis emitted from cars and public transport. City authorities can engage with industries and their populace to reduce the carbon emission from transportation through the provision of low-carbon transport solutions and encouraging people to use public transport and bicycles.

Primarily, the bulk of emissions from electric cars can be traced to the source of electricity used to recharge the vehicles. In the UK, for instance, where almost 80% of electricity is powered by fossil fuel, the use of electric vehicles could lead to as much as 30% savings in CO_2emission during use compared to a fossil fuel carHouses of Parliament, (2010). Electric vehicles can be easily charged at some public car parks or user's home. In Westminster, UK for instance about 12 on street charging points are available and about 48 charging points in car parks (GEM Cars, nd). In order to encourage the use of these cars, Westminster authorities provide reduced or free parking facilities for low carbon vehicles, in addition tax

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on electric vehicles are reduced. According to (Department of Transport, 2009) about £20 million was invested in low carbon vehicles by UK Department of Transport of UK has invested 20million pound for low carbon vehicles.A number of hybrid buses are now available with the ability toreduce CO_2 emissions by 30-40% compared to conventional buses. From 1 April 2009 operators of low carbon buses in the UK are to receive an additional 6 pence per km (Department of Transport, 2009).

Electric vehiclesproduce 0gCO_2/km emission whilst plug-in hybrid vehicle produce about 75gCO_2/km emission. Electric vehicles can travel a minimum of 70 miles after charging whilst the plug-in hybrid vehicles can travel a minimum of 10 miles after charging. Normally, manufacturers of electric vehicles offer a warranty on the vehicle and its main components. Typically, the manufacturer provide a warranty cover of at least 7 years (or 100,000 miles) for the battery and electric power train and 3 years (or 60,000 miles) for other conventional elements of the vehicle (Department of Transport, 2009).

Carbon footprint Reduction strategy for manufacturing industries

About 5.8 gigatons of CO_2 was emitted worldwide by industries in 2004, this does not include emissions from electricity generation and heat use. The following sectors of industries; non-metallic minerals (e.g. cement), iron and steel and chemical and petro chemicals were found to contribute about 70% of industrial emissions. (Materials Research Society, 2008)

✓ **For Iron and Steel manufacturing**

In iron and steel manufacturing, recycling materials could reduce the energy needed to produce new materials. Material recycling also has the potential to reduce CO_2 emissions substantially. In order to reduce CO_2 emission in iron and steel industry, the international iron and steel institute aims for the development of CO_2-free steel production processes. In some western countries for instance, several steel industries have adopted the use of technology to produce ultra-low CO_2 steel. The following processes have been adopted in order to reduce CO_2 emission:

- Blast furnaces in combination with CO_2 capture and storage.
- Natural gas based reduction processes with CO_2 capture and storage.
- Electrolysis production processes, similar to aluminium smelting. (Materials Research Society, 2008)

✓ **For Cement manufacturing**

A significant percentage of CO_2 is emitted by cement manufacturing worldwide. Due mainly to two factors; the huge global demand for cement, according to (Rubenstein 2012) cement after water, the next most consumed substance is cement. Similarly, Rubenstein added that, the calcinations process of cement manufacturing emits almost half of the direct greenhouse gas emissions originating from the entire process. According to (Materials Research Society, 2008), four approaches can be applied to increase the energy efficiency and reduce CO_2 emissions in the cement industry:

- Increase the process energy efficiency.
- Use coal fuel substitutes.
- Capture and store CO_2.
- Develop new cement types that reduce the use of cement clinker.

In cement manufacturing, clinker production is the most energy-intensive process which also emitted a substantial amount of CO_2 during cementmanufacturing. Reductions in the clinker/cement ratio through the utilization of clinker substitutes have the potential to reduce

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energy requirement which also reduces CO_2 emissions. Blast furnace slag is already a widely used clinker substitute. Fly ash, pyrite ash, and phosphogypsum are also the substitute of clinker (Materials Research Society, 2008).

CONCLUSION

Global warming and climate change are major environmental issues in today's world. Several developing countries and islands are suffering from the adverse impact of climate change. Even though they contribute only a minute amount of greenhouse gases when compared to most developed and industrialized countries. For this reason, developed countries should take appropriate methods to reduce carbon emissions. The developed countries should adopt the use of best available technology to reduce carbon and other greenhouse gas emission. In addition, these technologies or processes must be energy efficient in order to reduce their energy consumption. The United States and the European Union are currently involve or driving a change towards the reduction of greenhouse gases through the development of regulatory tools for carbon reduction. As climate change is likely to affect several countries all over the world, both developing and developed countries must work together to reduce their emissions levels.

REFERENCES

Adger, W.N., Huq, S., Brown, K., Conway, D., Hulme, M., 2003. Adaptation to climate change in the developing world. Prog. Dev. Stud. 3, 179–195.doi:10.1191/1464993403ps060oa

Ahmad Lotfi [Online], 2009.AUTOMOTIVE RCYCLING. http://www.lotfi.net/recycle/automotive.html. [Accessed 21 Sept 2010]

Bele, M.Y., Sonwa, D.J., Tiani, A.M., 2014. Local Communities Vulnerability toClimate Change and Adaptation Strategies in Bukavu in DR Congo. J. Environ. Dev331–357. doi:10.1177/1070496514536395

Borough Council of King's Lynn & West Norfolk [Online], 2009.Cavity Wall Insulation. http://www.west-norfolk.gov.uk/default.aspx?page=22400. [Accessed 24 Sept 2010].

Broer, S., &Titheridge, H. (2010).Enabling low-carbon living in new UK housing developments.

Carbon life Limited [Online], 2009. Carbon Reduction Strategy.www.carbonlifeltd.com/.../5.%20Carbon%20Life%20Services%20%20Carbon%20Reduction%20Strategy.pdf. [Accessed 03 Sept 2010]Management of Environment Quality: An International Journal (21) 1. p. 90 -107.

The Carbon Trust [Online], 2010. Why calculate a carbon footprint? http://www.carbontrust.co.uk/solutions/CarbonFootprinting/why_calculate_a_carbon_footprint.htm. [Accessed 28 August 2010]

The Carbon Trust [Online], 2010.Carbon footprinting.http://www.carbontrust.co.uk/cut-carbon-reduce-costs/calculate/carbon-footprinting/pages/carbon-footprinting.aspx .[Accessed 28 August 2010].Department of Energy & Climate Change, 2015. 2013 UK Greenhouse Gas Emissions, FinalFigures [WWW Document]. URL https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407432/20150203_2013_Final_Emissions_statistics.pdf (accessed 4.22.15).

ISSN 2055-0219(Print), ISSN 2055-0227(online)

Department of Envionment, Food and Rural Affairs, 2015. UK's Carbon Footprint 1997 – 2012 [WWW Document]. URLhttps://www.gov.uk/government/uploads/system/uploads/attachment_data/file/414180/Consumption_emissions_Mar15_Final.pdf (accessed 5.1.15).

Department of Transport [Online], 2009. Low Carbon Transport: A Greener Future . www.greener-journeys.com/themes/site_themes/gj/doc/low-carbon1.pdf. [Accessed 19 Sept 2010]

DIYnot [Online], 2010. Loft Insulation. http://www.diynot.com/pages/in/in002.php. [Accessed 24 Sept 2010].

European commission [Online], 2010. Climate change is happening. http://ec.europa.eu/environment/climat/campaign/what/understandingcc_en.htm. [Accessed 17 August 2010]

European Parliament, 2008. AN OVERVIEW OF GLOBAL GREENHOUSE GAS EMISSIONS AND EMISSIONS REDUCTION SCENARIOS FOR THE FUTURE [WWWDocument]. URL http://www.ieep.org.uk/assets/428/overview_gge.pdf (accessed 4.22.15).

Global Mathane Initiative, 2011. landfill: Reducing Emissions, Advancing Recovery and Use Opportunities [WWW Document]. URL https://www.globalmethane.org/documents/landfill_fs_eng.pdf (accessed 5.1.15).

Global Warming Art [Online], 2009.Global Carbon Emission by Type. http://www.globalwarmingart.com/wiki/File:Global_Carbon_Emission_by_Type_png. [Accessed 18 August 2010]

Gupta, M.D., 2014. Carbon footprint from road transport use in Kolkata city. Transp. Res. Part Transp. Environ. 32, 397–410. doi:10.1016/j.trd.2014.08.004

Hardoy, J., Pandiella, G., 2009. Urban poverty and vulnerability to climate change in Latin America. Environ. Urban. 21, 203–224. doi:10.1177/0956247809103019

Hayward, B., 2008. "Nowhere Far From the Sea": Political Challenges of Coastal AdaptationTo Climate Change in New Zealand. Polit. Sci. 60, 47–59.doi:10.1177/003231870806000105

Hertwich, E.G., Peters, G.P., 2009. Carbon Footprint of Nations: A Global, Trade-LinkedAnalysis. Environ. Sci. Technol. 43, 6414–6420.doi:10.1021/es803496a

Hopwood, N., Cohen, J., 1998. Greenhouse Gases and Society [WWW Document]. URL http://pratclif.com/climatechange/Greenhouse%20Gases.htm (accessed 5.3.15).

Houses of Parliament, 2010. Electric Vehicles - Postnote [WWW Document]. URL http://www.parliament.uk/documents/post/postpn365_electricvehicles.pdf (accessed 5.1.15).

Kachel, U., Jennings, G., 2010. Exploring Tourists' Environmental Learning, Values and Travel Experiences in Relation to Climate Change: A Postmodern Constructivist ResearchAgenda.Tour.Hosp. Res. 10, 130–115. doi:10.1057/thr.2009.34

Lee, K.-H., 2011. Integrating carbon footprint into supply chain management: the case of Hyundai Motor Company (HMC) in the automobile industry. J. Clean. Prod. 19, 1216–1223.
doi:10.1016/j.jclepro.2011.03.010

Madin, E.M.P., Macreadie, P.I., 2015. Incorporating carbon footprints into seafoodsustainability certification and eco-labels. Mar. Policy 57, 178–181. doi:10.1016/j.marpol.2015.03.009

ISSN 2055-0219(Print), ISSN 2055-0227(online)

Materials Research Society [Online], 2008. Reducing Industrial Energy Use and CO2 Emissions: The Role of Materials Science. www.mrs.org/s_mrs/bin.asp?CID=12527&DID=205806. [Accessed 13 Sept 2010]

Stolaroff, J., 2009. Products, Packaging and US Greenhouse Gas Emissions.Wiedmann, T., Minx, J., 2007.A Definition of "Carbon Footprint" [WWW Document]. URL http://www.censa.org.uk/docs/ISA-UK_Report_07-01_carbon_footprint.pdf (accessed 5.1.15).

Sustainable Glasgow [Online],2010. Glasgow's New Low Carbon Energy Systems. http://www.sustainableglasgow.org.uk/WhatWeDo/Pages/GlasgowsNewEnergySystems.aspx. [Accessed 06 Sept 2010]

UNFCCC [Online], 2010. Kyoto Protocol; http://unfccc.int/kyoto_protocol/items/2830.php [Accessed 16 Sept 2010]

Wright, C., Nyberg, D., Cock, C.D., Whiteman, G., 2013. Future imaginings: organizing inresponse to climate change. Organization 20, 647–658. doi:10.1177/1350508413489821

ISSN 2055-0219(Print), ISSN 2055-0227(online)