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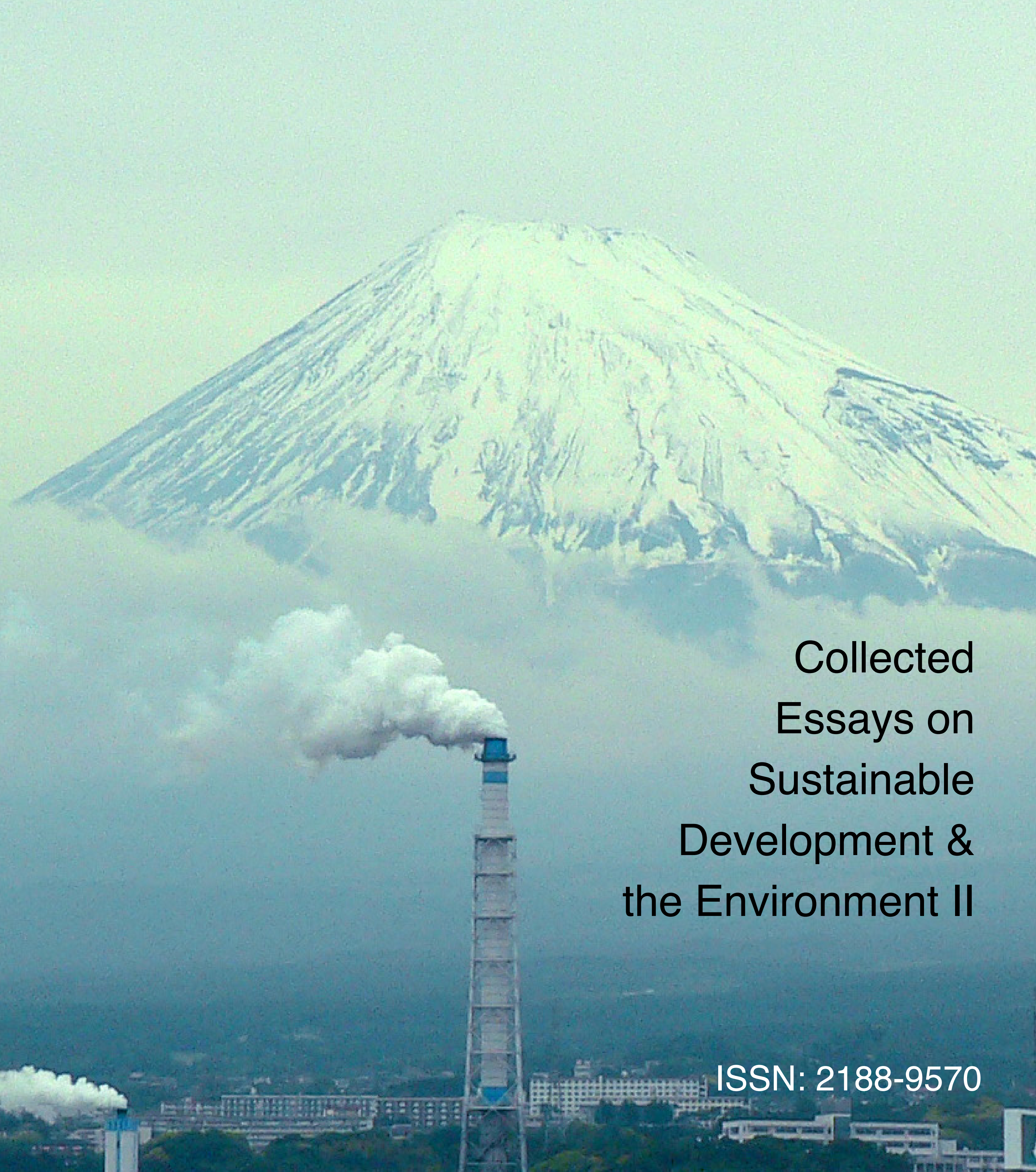

Collected Essays on Sustainable Development & the Environment II

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Editorial Committee Introduction

Welcome to Issue 9 Volume 1 of *The IAFOR Academic Review*. One of the central missions of The International Academic Forum (IAFOR) is to provide avenues for academics and researchers to be international, intercultural and interdisciplinary. One of the ways in which we do this is through our in-house magazine *Eye Magazine*, our various conference proceedings, our journals, and now beginning in 2015, our special editions of *The IAFOR International Academic Review*. In this edition we, the editorial committee, bring together a further selection of interesting contributions from our prior IAFOR Conferences with respect to the discussion of Sustainable Development and the Environment. Sustainable Development is ultimately about the interplay between people and ecologies by helping to meet the world's growing resource needs economically, culturally, socially and environmentally in the most responsible way possible. It is also about not taking the environment that we all share for granted and making sure that our resource use has equity placed at the centre of its use and management. Not just for today but also for the future. The papers selected by the editorial committee for this special edition certainly reflect the international, intercultural and interdisciplinary approach that lies at the heart of both IAFOR and the global goals of sustainable development and the environments we work and live in.

Sincerely,

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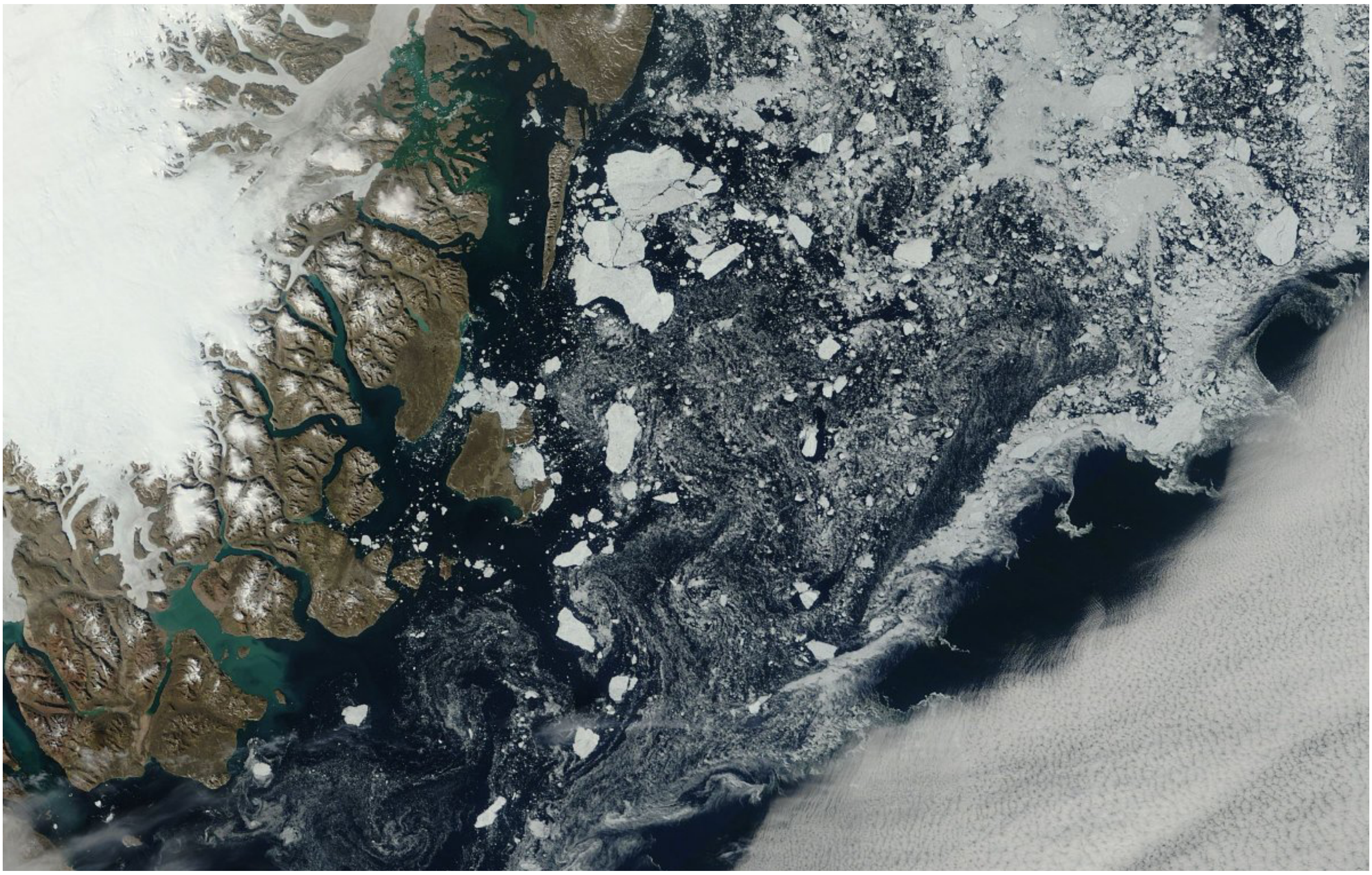
How Does the Energy Industry Deal with Climate Change?
Perception and Actions of the Energy Industry on Climate Change



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Abstract

The extent and pace of climate change is already beyond our expectation. Its impacts are now experienced in every country. There is no time to lose; not only to mitigate green gas emission for slowing down the current pace of change, but also to learn how to live with expected impacts, which were induced by previously emitted green gases. The energy industry, a motive power for economic development, is the main culprit of climate change but, at the same time, it is also vulnerable and sensitive to the change. This paper quantitatively and qualitatively analyzes perception and actions of major energy companies and discovers good examples for responding to climate change. First, this paper explores how the key bodies in the energy industry perceive and respond to climate change. The study utilizes companies' sustainability reports including annual reports from major 77 energy companies from the fortune 500 businesses (2012), and analyzes the disclosure patterns of the Global Reporting Initiatives (GRI) indicators. It also refers to the Carbon Disclosure Project (CDP) Global 500 on the Climate Change responses. Second, this paper selects the best cases of climate change response by the industrial value chain from production to transmission and scrutinizes them. It is discovered that many companies consider climate change as a challenge as well as an opportunity, but the extent of their responses were varied. It also proposes some suggestions on climate change response policies of the energy industry. The findings of this paper have practical significance, as it is one of rare researches on a specific private sector's response to climate change. Furthermore, it has policy implications for decision makers not only in the business sector but also in governments to support sustainable businesses and sustainable world.

1. Introduction

The extent and pace of climate change is already beyond our expectation. Its impacts are now experienced in every country. Rapid climate change has been severe and has created many problems throughout the world. Among the various definitions available for climate change, the definition offered by the United Nations Framework Convention on Climate Change is the most comprehensive. According to this definition, climate change is the change in the statistical properties of the climate system over long periods of time, regardless of cause. (IPCC, 2001) Moreover, climate change refers to a change in climate that is directly or indirectly attributed to specific human activity that alters the composition of the global atmosphere, and this change is above and beyond the natural climate variability observed over comparable time periods. (IPCC, 1994)

Demand for energy and associated services, to meet social and economic development and improve human welfare and health, is increasing. (IPCC, 2011) All societies require energy services to meet basic human needs and to serve productive processes. Since approximately 1850, global use of fossil fuels has increased to dominate energy supply, leading to a rapid growth in carbon dioxide (CO2) emissions. (IPCC, 2011) Accordingly, the energy industry is being blamed for much of the observed climate change because this industry is a major source of carbon dioxide, which has been shown to contribute to climate change. However, this industry is also vulnerable to impacts of climate change, and those impacts must be analyzed to make plans not only for mitigation but adaptation to climate change. These activities will eventually increase the sustainability of the energy industry. This paper analyzes the risks and opportunities of the energy industry created by climate change, and summarizes how the energy industry copes with these risks and opportunities. This paper also highlights the current and emerging best practices within the energy industry and provides future recommendations for policies regarding climate change for policy makers and managers in the energy industry.

Companies in this sector have large fixed assets with long lifetimes assets that are vulnerable to climate impacts predicted to become increasingly severe over time. (Ceres, 2011) Therefore, it faces climate change impacts on its own operations. Furthermore, the mining companies face potentially significant risks from the physical effects of climate change, largely because the sector is very water- and energy intensive and operates in some very politically challenging countries. (Ceres, 2011) These activities will help the energy industry's sustainability. This paper is to discover the risks and opportunities of climate change in the energy industry and summarize how the energy industry copes with these risks and opportunities. To promote the idea in the industry it also highlights the current and emerging best practices. Finally it will help provide recommendations for policy makers and managers in the energy industry.

2. Research Resource and Structure

Companies that compete globally are increasingly required to commit to and report on the overall sustainability performances of operational initiatives. (Carin Labuschagne, 2003) The Global Reporting Initiative's (GRI) and Carbon Disclosure Project (CDP) provide with very useful tool to figure out the sustainability trend. The GRI's vision is that reporting on economic, environmental, and social performance by all organizations becomes as routine and comparable as financial reporting. (GRI, 2009) Companies will disclose all relevant sustainability information using GRI guidelines, as well as additional sector-relevant indicators. (Ceres, 2011) Carbon Disclosure Project (CDP)—Since 2003, the CDP has been requesting information from corporations on their greenhouse gas emissions footprint and the risks, including physical risks, related to climate change. In 2011, more than 3,700 companies responded to the CDP questionnaire. This research focuses on the energy industry in terms of the climate change. Scope of energy industry is vast and it also has the anterior and posterior effects. Given the immense and diverse nature of this industry, this research cannot cover all corporations within this market segment. Therefore, the focus of this research is limited to corporations in the energy industry that were named on the Fortune 500 list in 2012. This includes also companies in the category of Oil, Gas, Fuels, Energy Equipment, and Services and corporations within the energy industry as defined by the GRI and the CDP. This paper explores how the key bodies in the energy industry perceive and respond to climate change. The study utilizes companies' sustainability reports including annual reports from major 77 energy companies.

3. Climate Change Risk and Opportunity

Climate change can definitely affect business operations. Indeed, these changes can present both risks and opportunities. Table 1 shows the climate change phenomena and the predicted future trend for each phenomenon. Potential impacts of climate change – on natural resources, unmanaged ecosystems, sea level rise and water resources

– are hard to be estimated and make prevention actions.

Table. 1 Climate Change Phenomenon Likely to Affect to the Energy Industry (IPCC) [1]

Phenomenon	Likelihood of trend
Contraction of snow cover areas, increased thaw in permafrost regions, decrease in sea ice extent	Virtually certain
Increased frequency of hot extremes, heat waves and heavy precipitation	Very likely to occur
Increase in tropical cyclone intensity	Likely to occur
Precipitation increases in high latitudes	Very likely to occur
Precipitation decreases in subtropical land regions	Very likely to occur
Decreased water resources in many semi-arid areas, including western U.S. and Mediterranean basin	High confidence

Corporations can make decisions whether to take action or not in the face of specific results of climate change. If they decide to take action, two approaches are available, i.e., mitigation and adaptation. According to the Intergovernmental Panel on Climate Change (IPCC) definition, climate change mitigation focuses on efforts to reduce greenhouse gas (GHG) emissions and/or enhance the removal of these gases from the atmosphere through carbon sinks. (B. Metz et al., 2001) In contrast, adaptation to global warming is a response that seeks to reduce the vulnerability of biological systems to climate change effects. Even if emissions are stabilized relatively quickly, climate change and its effects can last many years, thereby making adaptation necessary. (Farber, Daniel, 2007) In actuality, adaptation is a necessary strategy for all players in the energy industry and should be used to complement any climate change mitigation efforts. Adaptation, sustainable development, and enhancement of equity can be mutually reinforcing. (Grida.no , 2001)

[1] Definitions of likelihood ranges used to express the assessed probability of occurrence: *virtually certain >99%, very likely >90%, likely >66%.*
Source: Summary for Policymakers, IPCC Synthesis report, November 2007 http://www.ipcc.ch/

4. Perception of Climate Change from a Corporate Perspective

The energy industry heavily depends on natural resources, such as fossil fuels, water, and land. Moreover the energy industry will confronted with the resource management crisis. Water is one of the critical resources. Water risk was raised by business executives in the World Economic Forum in Davos, 2013. More than 1.2 billion people already face water scarcity. By 2025, two-thirds of the world population will experience water stress. (Bloomberg 2013) The issues of complex linkages between food, energy, and water will be raised more and energy sector will take more risk on their operation. Water stress will be more severe according to the IPCC scenario. In fact, 76% of the total water demand comes from the energy industry in Northeast Asia with the current pattern of energy use and energy mix. The energy companies in this study have indicated that they have adopted a heightened sense of awareness of the risks and opportunities induced by climate change. According to the CDP survey in 2012, the energy industry recognizes more climate risks (e.g., managing emissions and disclosing the alignment of the overall business strategy) than opportunities.[2]

The energy companies indicate a heightened sense of awareness of the risks and opportunities. According to the CDP survey in 2012, the energy industry considered climate change as a risk rather than an opportunity. Such as managing emissions and disclosing an alignment of the overall business strategy. [3] Threats to business continuity due to increases in intensity and frequency of extreme events caused by climate change can be significant risks created by climate change. These extreme events can threaten the raw material supply and distribution chains, which would clearly affect the industry's ability to produce the needed energy. In actuality, adaptation is a necessary strategy for all stakeholders in the energy industry and should be used to complement any climate change mitigation efforts.

Uncertainty about climate change regulations and increased costs due to the introduction of carbon taxes can create significant doubt in the business environment and business operations. Therefore, the changes made by the government in an effort to address climate change risk also make an impact on the financial side of the energy companies. Moreover, in terms of environmental management, optimistic emission reduction efforts result in significant cost implications for all energy sector companies. Additionally, changes in consumer needs from conventional energy to renewable energy are changing the face of the energy industry. For a conventional energy corporation, this could possibly present a major negative impact on their revenue.

Despite the many associated risks, climate change also creates some benefits. For example, companies that are up-to-date with climate change policy changes can make additional revenue from reducing emissions, and they can be a player in the emission trading market. Also it is expected to see new market creation (ex. energy efficiency technologies, renewable energy) and it will create massive investment.

5. Disclosure Analysis

This paper is based on disclosure information collected in the form of the GRI indicator. The GRI disclosure index is composed of the items. Table 2 described and covers all corporate activities in relation to climate change. The ten indicators in the GRI index relate to the adaptation and mitigation activities associated with climate change.

Table. 2 GRI Indicators relating to Climate Change

Indicator	Explanation
EC2	Financial implications and other risks and opportunities for the organization's activities due to climate change.
EN2	Percentage of materials used that are recycled input materials.
EN5	Energy saved due to conservation and efficiency improvements.

[2] Survey rate is not the same at the each industry level within the energy industry.
[3] Survey rate is not the same at the each industry level in the energy industry.

EN6	Initiatives to provide energy-efficient or renewable energy-based products and services, and reductions in energy requirements as a result of these initiatives.
EN7	Initiatives to reduce indirect energy consumption and reductions achieved.
EN10	Percentage and total volume of water recycled and reused.
EN18	Initiatives to reduce greenhouse gas emissions and reductions achieved.
EN13	Habitats protected or restored.
EN14	Strategies, current actions, and future plans for managing impacts on biodiversity.
EN26	Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation.

Figure 1 shows the percentage of energy industry companies on the 2012 Fortune 500 list that used the GRI indicators for their sustainability reporting. It is worthy of note that the general energy industry has a high rate of reporting. Nevertheless, engineering companies report at the minimum rate. Also, note that the companies that published sustainability reports without reporting the GRI indicator were not included in this quantitative analysis.
Figure 2 shows that the disclosure rate in the energy industry by sector. The disclosure rate is very high in the oil and gas equipment industry, whereas the pipeline industry has the lowest disclosure rate as it is associated with many environment impacts and sensitive issues. The disclosure patterns for environment information and climate change information is similar in most segments of the industry, but the reports from the electric, mining/crude oil, and petroleum refining segments reveal more climate change activities than general environmental activities.

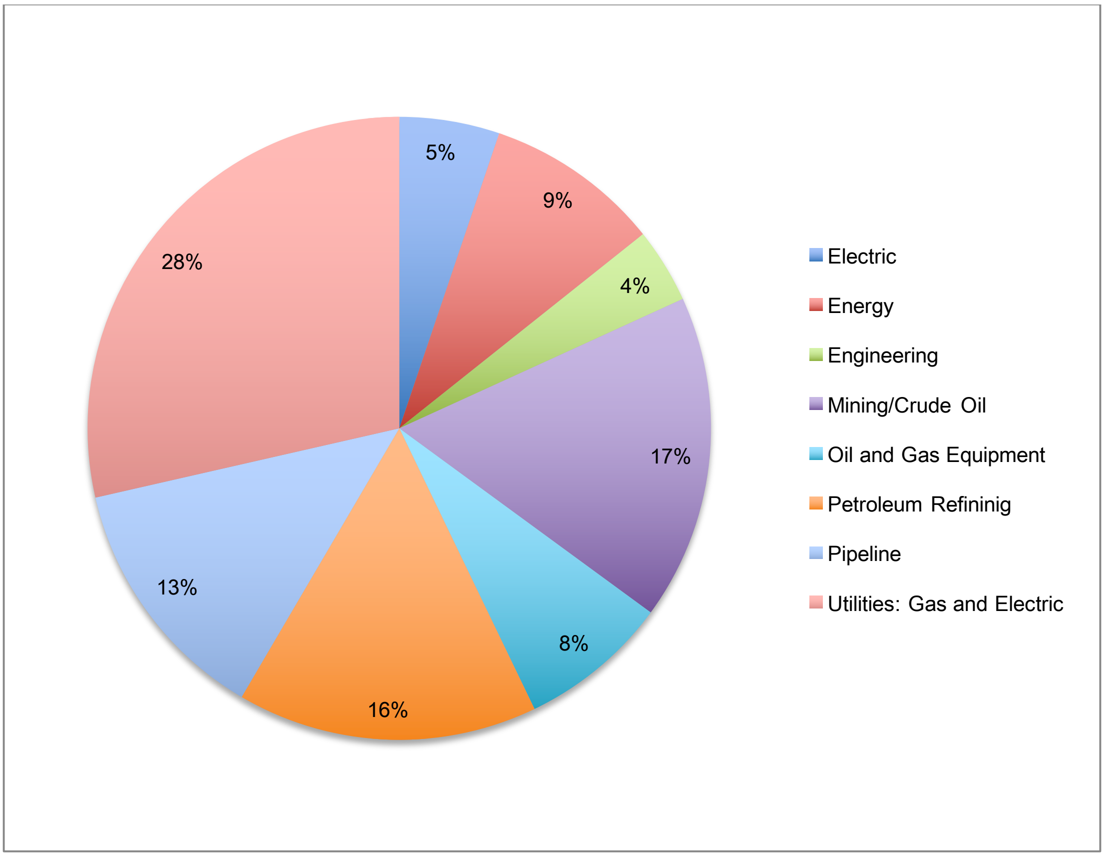


Figure 1. Reporting Rate by Sector in the Energy Industry

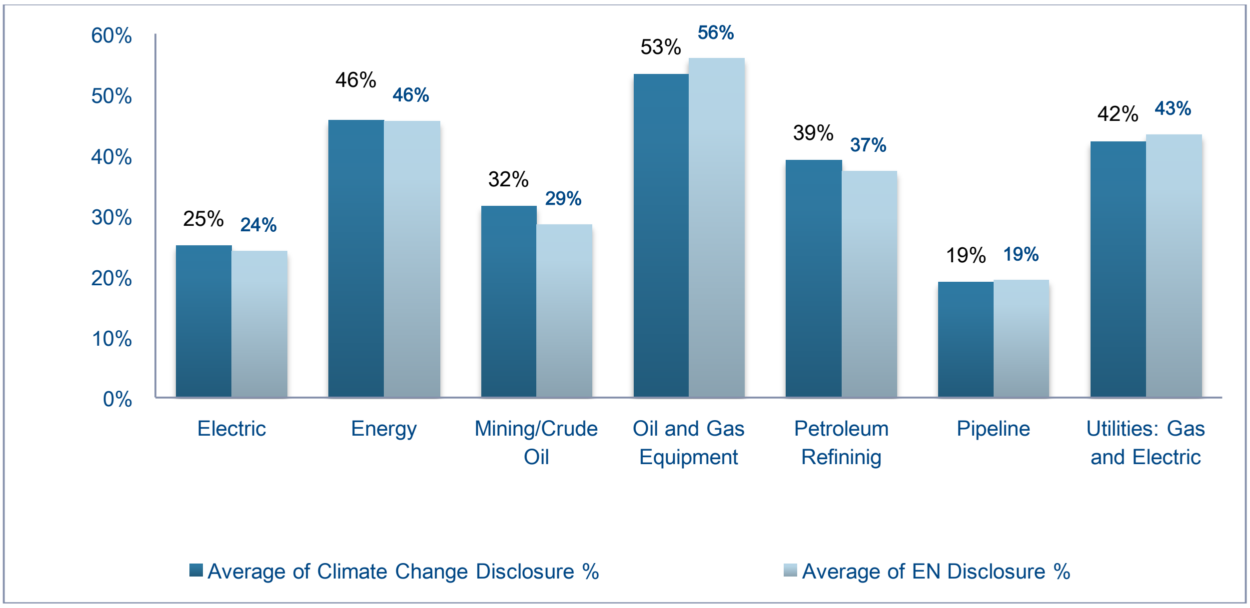
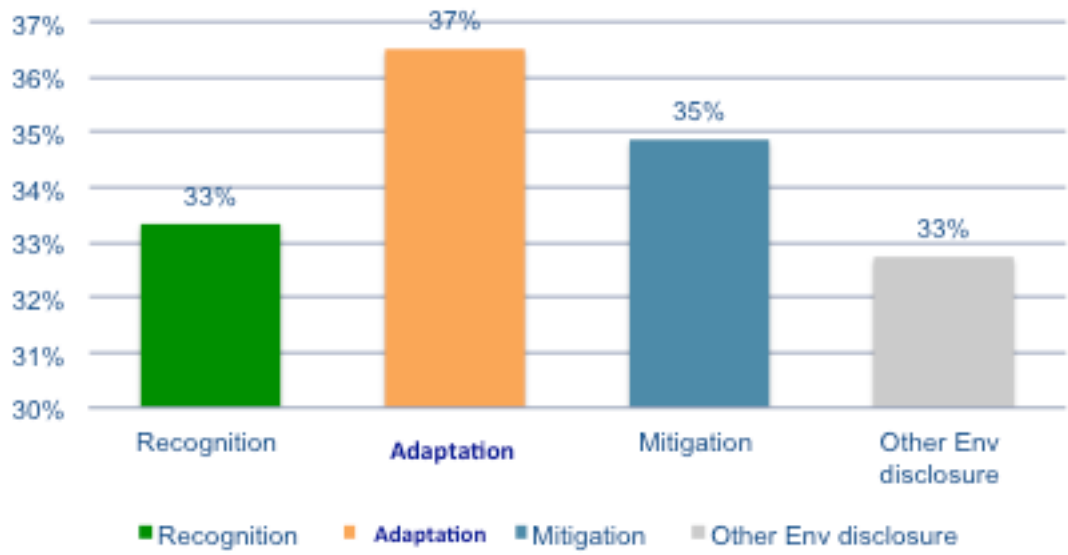


Figure 2. Comparison of Disclosure between Climate Change and Environment by Sector

The nature of the disclosure can be categorized into the following four categories: recognition adaptation, mitigation, and the others. The average of adaptation disclosure in the energy sector is higher than the mitigation disclosure. The percentage of material used is the lowest disclosed indicator. Recognition of climate change is also not highly disclosed as it is an initial step to respond to climate change. Companies often report to recognize climate change in a certain year, and they only report to the follow-up measures in the following years. Adaptation and mitigation activities are often treated as the activities of risk management, and new market development and creation in the energy industry.

Figure 3: Disclosure Rate By Category (i.e., recognition, adaptation, mitigation, and the others)

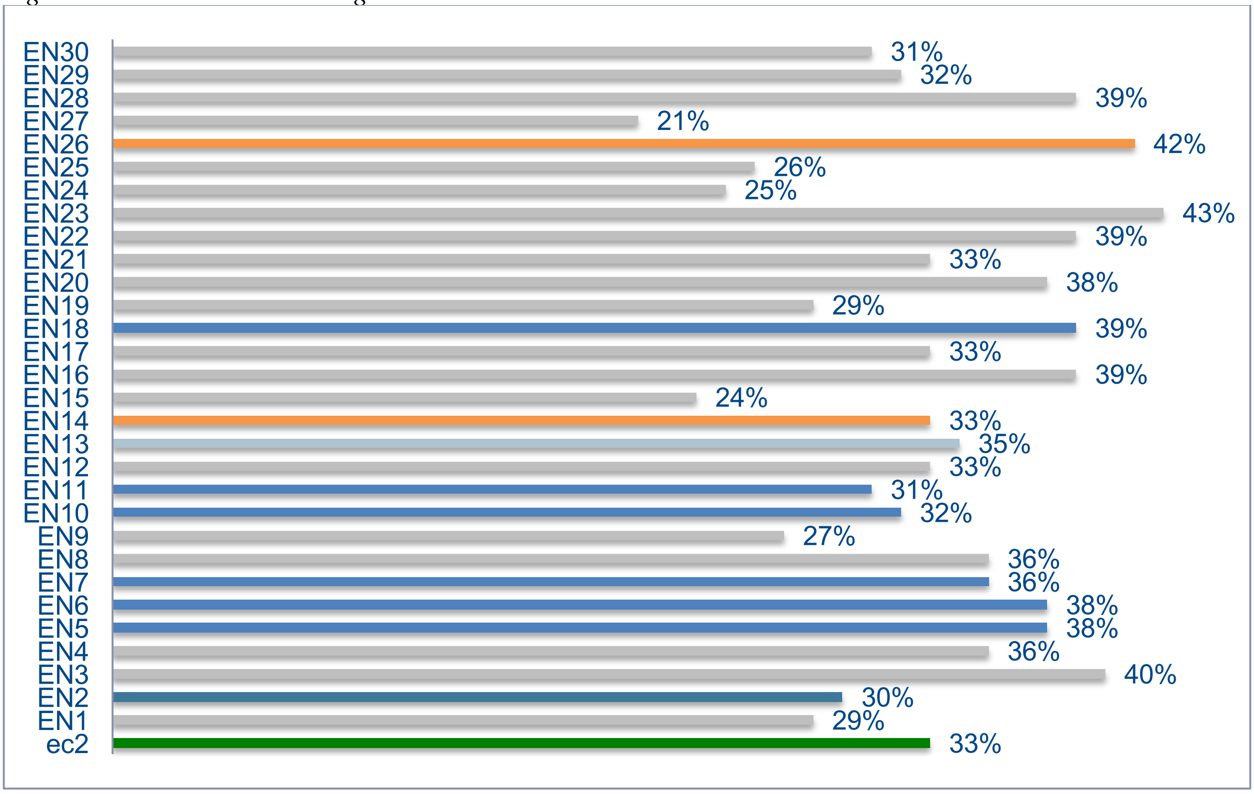


[4]

Figure 4 shows the disclosure rate for each indicator. Companies are very active in reporting EN 27 and EN15. Among the adaptation indicators, EN 26 got the highest disclosure rate. In terms of mitigation, EN 18 had the highest disclosure rate, and EN2 had the lowest.

[4] Fortune 500, 2012 Oil and gas and utility industry, 38 out of 72 were only eligible produced the reliable information, 2010 -2012 data

Figure 3. Disclosure Rates according to GRI Indicators



6. Action Analysis - Adaptation/Mitigation

This paper analyzes the self-reported information in relation to climate change of the Fortune 500 energy corporations. Although the presented data is based on limited information, it illustrates the level and scope of activities on climate change within the industry. Figures 5 and 6 show some companies' activities related to climate change adaptation and mitigation. It is challenging to illustrate their activities as its extent and pattern are varied. However, to indentify the difference among the companies, the paper categorizes the companies according to their business type (e.g. upstream, and downstream), and pays attention to the difference between the categories. There is some limitation in this analysis. First, the boundary between downstream and upstream is unclear. Second, it is difficult to assess the companies' activities as some of them are only pledged and not yet proved to be implemented.

Consequently, more activities related to adaptation are found than the activities in relation to mitigation. For the adaptation strategies, weather is a very important action variable. Such companies as EVN conducted risk site assessments. The facilities of Encana, Wood Group, and FirstEnergy are well suited to endure potential temperature and weather-related shifts. Moreover, some companies took action on adaptation in their business plans by implementing employee training and resource management. Based on their recognition that water will be affected by climate change, Transocean and Sempra Generation implemented water recycling in effluent processing to allow the reuse of residual water. Exxon spanned multiple industries and developed new technologies that can improve resilience to climate change. Occidental Petroleum adopted a long-term view of research on climate change and the potential human influences on the climate. Furthermore, some companies (e.g., the EDF Group) even tried to promote energy efficiency with the end user.

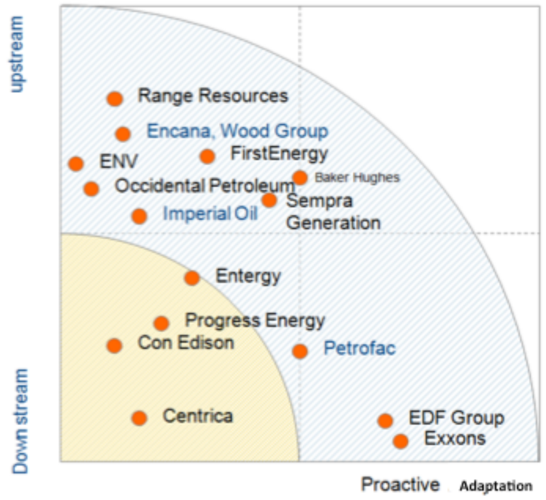


Figure 5. Adaptation Activities Analysis

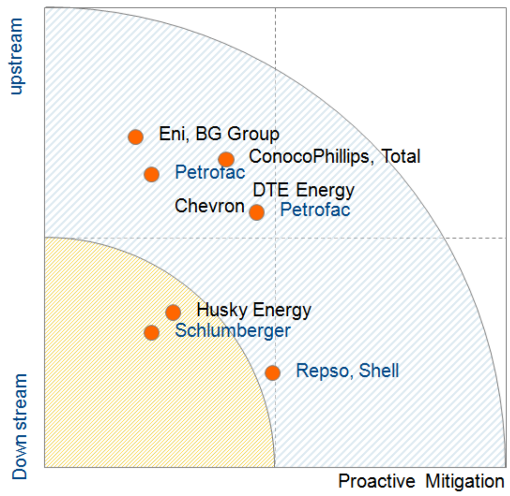


Figure 6 Mitigation Activities Analysis

Mitigation related activities were not reported as much as the adaptation related activities, but some promising activities was found in the disclosed information. Profac, Chevron, and British Gas expanded their operations into the renewable sector. CoconoPhillps diversified their energy sources. In terms of the carbon issues, Schlumberger, Husky Energy, Eni, and DTE Energy actively used carbon capture and storage (CCS) technologies.

7. Findings and Discussions

Climate change will likely impact the production, demand, and distribution of energy. As the energy industry has contribute to increasing CO2, the action made by the energy business for climate change can help to mitigate the speed of climate change over all. At the same time, the energy industry is the one to be prepared for responses to this rapid change in order to survive. It is encouraging that this industry is showing signs of recognizing the risks and opportunities induced by climate change. Adaptation and mitigation actions are slightly propagated in the oil and gas industry. Even though there are some recognition and engagement actions, by the nature of corporate, pursuit of profits, their actions are very limited.

According to the Environmental Protection Agency (EPA, U.S.), climate change will likely impact the production, demand, and distribution of energy. Although the energy industry has contributed to the increase in carbon dioxide in the atmosphere, the actions taken by the energy industry in an effort to address climate change can help to mitigate the overall speed of climate change. Furthermore, this industry needs to be prepared for these rapid changes in order to survive. The fact that this industry is showing signs of recognizing the risk and opportunities induced by climate change is encouraging. However, adaptation and mitigation actions in the oil and gas segments still are few. Even though we can identify some prevention and engagement actions, these actions are limited due to their impact on profits. Nevertheless, mitigation and adaptation actions will improve corporate sustainability. In conclusion, to promote actions on the industrial level, strategic alliances are needed. Additionally, stakeholder management, including customers, is needed. Moreover, some actions are also needed on the policy making level. Global agenda setting, and quality and quantity assessment in terms of mitigation and adaptation are needed. The GRI index is fairly a good indicator and can be used generally to share the company information with the related stakeholders. Political power and market power is very essential to make a real change. The industry by itself is difficult to be changed. Therefore, appropriate incentives as well as supports from outside are necessary for the industry to be change. Especially, political stability can act as an incentive. Furthermore, carbon taxes and subsidies for low carbon technology can also help the overall corporate strategy. If the carbon trading market is normalized and fully established with various stakeholders including the corporate that emit carbon dioxide, those corporate will be more active on these issues. These components are interlinked with one another. Last but not the least, education on sustainability and climate change to the public (e.g., stakeholders, customers, and communities) is also important. Many companies have mentioned that the change in consumer's attitude is one of the highest risks associated with climate change. This type of education will be eventually a help to the corporation's business.

8. Concluding Comments and Research Implications

One of the more significant findings deducted from this study is that many companies in the energy industry starts to consider climate change as a challenge as well as an opportunity, but the extent of their responses were varied. The findings of this paper have practical significance, as it is one of rare researches on a specific private sector's response to climate change. Furthermore it has policy implications for the decision makers not only in the business sector but also in governments to support sustainable businesses and sustainable world.

To date, little research relating to climate change adaptation and mitigation in the oil and gas industry has been published. There is no unified method to check corporate actions related to climate change. Cost-benefit analysis is only applicable if the variances of both costs and benefits are finite. In the case of climate change, the variances of the net present marginal costs and benefits of greenhouse gas emission reduction need to be finite. Finiteness is hard, if not impossible to prove. (Richard, 2003) However, an experimental and trial analysis can be initiated first, and it will eventually be a help to make the market more climate change friendly.

Even though this study could serve as a good start toward creating a research model, it is limited in terms of the quality and quantity of the data used. This research is entirely based on corporate sustainability reports. It must be noted that self-reports from corporations can be biased. Also, there is a possibility that some corporations may be active in these issues without reporting their activities. Furthermore, the disclosure information reported may not accurately reflect their actual adaptation or mitigation actions. Indeed, the quantity of information does not necessarily relate to the quality of action, and the reporting culture and rules vary according to the source of energy and the region in which the energy is produced. The current indicator frameworks that are available to measure overall business sustainability do not effectively address all aspects of sustainability at operational level, especially in developing countries such as South Africa. Social criteria, specifically, do not receive due considerations. (Carin Labuschagne, 2003)

The time period for which the data represents is also very limited. In fact, the corporate sustainability report covers a period no longer than 5 years. Most of companies also publish the reports less than two times. Lack of available information makes difficult for this research to figure out a significant trend of the energy industry. Moreover, comparing the actions of the companies is also difficult due to time and regional variations. This research used the sustainability report that has been published for the past 3 years. Nevertheless, the time period for the data collection is hard to coordinate for all of the companies becuase the regional and national laws do not apply to the each company in the same manner. Lastly, this paper is based on the energy companies on the Fortune 500 list; therefore, it is not a good representation of the renewable energy industry, which is still in its infancy.

References

CDP - Driving sustainable economies https://www.cdproject.net
Global Reporting Initiative https://www.globalreporting.org/
Modeling the Impacts of Climate Change on the Energy Sector: a Swiss perspective , Camille Gonsethy and Marc Vielle, Research group on the Economics and Management of the Environment(reme.epfl.ch)30 mai 2012
(Annex I. In: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (B. Metz et al. (eds.))
[Farber, Daniel A. Adapting to Climate Change: Who Should Pay"], 23 FLA. ST. U. J. LAND USE & ENVTL. L. 1, 8 (2007)
Climate Change 2001: Impacts, Adaptation and Vulnerability". Grida.no. Retrieved 2010-08-29
Climate Change. Education Center – Arctic Climatology and Meteorology. NSIDC National Snow and Ice Data Center. ; Glossary, in IPCC TAR WG1 2001.
The United Nations Framework Convention on Climate Change". 21 March 1994.
Adapting to Climate Change: A Guide for the Energy and Utility Industry Tiffany Finley, Associate, Advisory Services Ryan Schuchard, Manager, Climate and Energy, BIS
IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation- This Summary for Policymakers was formally approved at the 11th Session of Working Group III of the IPCC, IPCC, 2011
Assurance statement practice in environmental, social and sustainability reporting: a critical evaluation B O'Dwyer, DL Owen - The British Accounting Review, 2005
Corporate environmental disclosures about the effects of climate change E Stanny, K Ely - Corporate Social Responsibility and Environmental Management, Volume 15, Issue 6, pages 338–348, November/December, 2008
Assessing the sustainability performances of industries
Carin Labuschagnea, Alan C. Brenta, Ron P.G. van Erck, Journal of Cleaner Production Volume 13, Issue 4, March 2005, Pages 373–385, 2003
From Risk to Opportunity Insurer Responses to Climate Change , E Mills Ceres Report, 2009
Corporate governance and climate change: Making the connection DG Cogan ,Cres, 2006
The Road to 2020: Corporate Progress on the Ceres Roadmap for Sustainability, Ceres, 2011
Physical Risks from Climate Change: A guide for companies and investors on disclosure and management of climate impacts,Ceres, 2011
Water Risk to Business Is No Small Drip (Bloomberg 2013.01.30)
Is the uncertainty about climate change too large for expected cost-benefit analysis? Richard S. J. Tol , Climatic Change, 2003
Estimates of the damage costs of climate change. Part 1: Benchmark estimates,Richard S.J. Tol, Environmental and Resource Economics, 2002

Opening image credit: East Greenland Terra MODIS ice cap covering the Arctic Ocean. Flickr Creative Commons/gsfc (NASA Goddard Space Flight Center)

Resource Consumption, Material Flow and Economic Growth: the Case of the Philippines

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Abstract

This study utilizes the method of Economy-wide Material Flow Analysis (EW-MFA) to examine the trends in the resource consumption, material flow and economic growth from 1985 to 2010 in an archipelagic, developing and newly industrialized country, the Philippines. Disaggregate presentation of EW-MFA indicators in terms of material categories such as fossil fuel, biomass, ore and industrial minerals, and construction minerals attempts to elucidate the consumption patterns and the impacts to the environment. Since only few studies on the EW-MFA were done in the developing countries, this research can be regarded as one of the first attempts to study the economic growth of the Philippines in terms of physical dimensions. Results show that the annual amount of per material category of DMC increased significantly with biomass (70%) and construction minerals (13%) as the most consumed materials in 1985, however, construction minerals increased to 41% while the biomass decreased to 42% in 2010. The IPAT (Impact (I) = Population (P) x Affluence (A) x Technology (T)) analysis shows that population (P) and affluence (A) are the key driving forces of resource consumption in the Philippines. The decoupling condition of resource consumption from economic development shows varying trends of non-decoupling and relative decoupling in a 25-year period reflecting the development plans and strategies implemented throughout the study period. The results of this research are intended to assist in the future development strategies towards the sustainable resource management and sustainable development in the Philippines.

Key Words: Material Flow, Consumption, Decoupling, Economic growth

1. Introduction

It is the ultimate goal of every economy to reach a certain degree of development and so for last decade, global efforts to improve the low-income economies had resulted to unprecedented growth of economies and uplifted the significant number of populations out of the poverty line all over the world. Tantamount to the growth of economies is rapid withdrawal and utilization of the materials and energy from the environment. While these resources provide the basic needs of the socio-economic system, the extraction, processing and utilization of these resources bring disturbance to the natural ecosystem affecting biodiversity, displacement, and wastes discharged to the environmental system. This environmentally unsustainable global consumption of natural resources resulted to the numerous environmental problems being experienced encompassing the developed and developing economies all over the world. The rate of resource consumption has been rapidly increasing, with the industrialized and developed countries consume greater amount of resources than the developing counterparts and more so if the developing countries would follow the trends of resource consumption in these developed regions.

The worldwide uneven distribution and the supply of the natural resources are also important factors to consider in the current trends of resource consumption. While the developed countries such as Japan and other European countries are now gearing towards utilizing technological innovations, putting institutional framework and policies in placed to de-link or decouple the resource consumption and economic growth, the developing economies at the early stage of economic growth should also consider growth patterns and strategies that promote sustainable resource consumption. The resource decoupling would occur when the growth in the resource consumption is lower than the economic growth, and while this concept is not a panacea to the current complex socio-economic and environmental issues, it is still important to look into as decoupling encourages the increase in the resource efficiency and productivity.

The Asia-Pacific region is regarded as not only the center of economic growth in the world in terms of financial production and consumption but at the same time, this region has the highest growth rates in the demand and utilization of materials and energy (Giljum et. al, 2010), registering the regional average of 85% per capita material use terms with that of the rest of the world. The fast phase of economic growth in this region has been considered to be unsustainable as characterized by the rapid growth of population; increased resource utilization and rapid urbanization challenge the region's sustainable development (UNEP, 2013). The current patterns of economic growth in Asia would later affect the global demand and consumption of materials and the subsequently affect the global environment such as increased emission of greenhouse gases and other forms of wastes.

To determine the resource consumption of the region or country, the development of physical accounts to quantify the flow of resources from environmental system to socio-economic system using the economy-wide material flow accounts (EW-MFA) is one of the important methods that gained popularity in providing useful information on the resource extraction, consumption patterns and growth of the economies that could be used and related to the global, regional, national and local socio-economic and environmental issues. The EW-MFA is well studied and adopted framework in the developed countries but not widely applied in the developing countries. Recently, comparative case study on assessment of economy-wide material flow accounts and implications was conducted for the developing countries such as Myanmar, Bangladesh and Philippines. Similarly, the study on driving factors of resource flows in Myanmar, the Philippines and Bangladesh have been undertaken (Kyaw, et. al, 2014). Studies incorporating resource consumption indicators with economic growth by utilizing the decoupling analysis were done for China, Russia, Japan and United States (Wang, et. al, 2013) and Czech Republic (Kovanda et. al, 2007).

The Philippines is one of the countries in Asia Pacific region that pledged commitment to the joint Asian policy called the Manila Declaration on Green Industry in Asia in 2009. This declaration called for the need to increase resource efficiency, inclusive economic growth in the developing countries and reduction of resource consumption in the high-consuming countries in the region. As a newly industrialized country, it is timely to look into the Philippines' scenario of resource consumption in disaggregated, per material flow and implications on economic growth. This study also attempts to determine the drivers of resource consumption and look into the pattern of economic growth and resource consumption in terms of decoupling analysis to provide basis for the sound resource management in the Philippines.

This research is organized as the following; Section 1 gives the introduction and background of this research, Section 2 presents the socio-economic system of the Philippines while the Section 3 presents the methodology in the calculation of EW-MFA indicators and identifying the driving factors and decoupling trends. Section 4 shows the discussion and analysis of trends of the indicators of EW-MFA. The driving factors of resource consumption and the decoupling trends in the national economy of the Philippines are also discussed in this chapter. Section 5 presents the conclusion and recommendations for future research.

2. The Philippine's Socio-Economic System

The Philippines is an archipelagic country lying in the southeastern coast of Asia composed of 7,107 islands stretching to an area of 300,000- square kilometer or 29.8 M hectares. Manila is the capital city and at center of economic activities in the country. Philippines is one of the member states of Association of South East Asian Nations.

2.1 Gross Domestic Product (GDP) and Population

The Philippine population is characterized by a high birth rate and gradually declining mortality rate. Since the international migration is relatively nil, the growth in population is greatly attributed to the natural increase or the excess of births over deaths (PSY, 2010). The population increased from 54 M in 1985 to 93 M in 2010 (Worldbank, 2014) with compounding annual growth rate of 2%. The disparity in the spatial distribution of the country's population maybe attributed to its geographical, socio-economic and climatic conditions. Similar to the global trend of urbanization, the urban population of Philippines rose from 48% in 2000 to 61% in 2007. It has population density of 308 per square kilometers in 2010 (PSY, 2010).

The performance of the Philippine economy has been characterized by a regular pattern of boom and bust growth cycle since the 1970's. Because of this, the GDP (constant, 2005) modestly increased from 49,277 Million US$ in 1985 to 131,131 Million US$ in 2010 (Worldbank, 2014) with compounding annual growth rate of 4%. The per capita GDP (constant 2005) also grew modestly from $912 in 1985 to $1,406 in 2010. The potential growth of per capita GDP appeared to be significantly constrained by a high population growth rate.

2.2 Structural Economic Transformation

There is a gradual shift in the Philippines' economic structure changing from the high share of agriculture in the GDP to growing shares of industrial and service sectors. Table 1 shows the changes in the economic structure of the Philippines from 1985 to 2010. In 2010, the industry and service sectors comprised 88% of the shares to national GDP. In terms of per sector share in GDP, the share of agriculture showed decline from 24.6% in 1985 to 12.3% in 2010. Similarly, industry share decreased from 35 % in 1985 to 33% in 2010, while the services increased from 41% in 1985 to 55% in 2010.

Table 1. The Philippines' Key Socio-Economic Indicators from 1985 to 2010

Indicators	1985	1990	1995	2000	2005	2010
Population, million	54	62	70	78	86	93
Population density, (people/km^2)	182	208	233	260	288	308
GDP, million US$ (2005 constant)	49,277	62,100	69,125	82,354	103,066	131,131
GDP, US$ (2005 constant)/capita	912	1,002	993	1,061	1,201	1,403
Agriculture (value added, % of GDP)	25	22	22	14	13	12

Industry (value added, % of GDP)	35	34	32	34	34	33
Services (value added, % of GDP)	41	44	46	52	54	55

(Sources: Worldbank 2014 and Philippine Statistical Yearbook, various years)

3. Methodology

3.1 Sources of Data

The methods for the estimation of the indicators and the categorization of the major types of resources in this study of material flow accounting and analysis are based on the standardized and methodological guidebook released by Eurostat (2001, revised 2009). Table 2 shows the four major resource types or categories of the materials accounted for in this research and the sources of data. The data for indicators of material flow accounts are also presented at this level of disaggregation. The quantity of all material per categories is expressed in terms of their mass (weight in tonnes) per year. In this research, the physical material flow is determined with the focus on the direct material flow or the economically used resources only. This research does not consider the indirect material flows or unused materials associated to the exports or imports and the hidden material flows from the domestically extracted materials such as the mining overburden or unused byproducts from agricultural harvests.

Table 2. Data Sources and the Four Major Resource Categories of EW-MFA

Material Category	Sub categories	Data Sources
Biomass	From agriculture, forestry, and fishery	Philippine Statistical Yearbook Bureau of Agricultural Statistics Bureau of Fisheries and Aquatic Resources
Fossil Fuels	Fossil energy carriers such as coal, oil, natural gas, and others	Philippine Statistical Yearbook Department of Energy
Ores and Industrial Minerals	Precious metals and base metals ores, industrial mineral, and others	Philippine Statistical Yearbook
Construction Minerals	Sand and gravel, and others	Philippine Statistical Yearbook

3.2 Calculation of EW-MFA Indicators

3.2.1 Domestic extraction (DE)

DE refers to the amount of the materials obtained from the Philippine environment. It is estimated by using the equation below.

$$DE_{(t)} = \sum_{x}^{y} \left\{ B_{x(t)} + F_{x(t)} + M_{x(t)} + C_{x(t)} \right\}$$

$\mathrm{DE}_{(t)} = \sum_{x}^{y} \{ \mathrm{B}_{x(t)} + \mathrm{F}_{x(t)} + \mathrm{M}_{x(t)} + \mathrm{C}_{x(t)} \}$The $DE_{(t)}$ stands for domestic extraction at year *t* totaling of all types of material types from *x* to *y* for each type of categories. The material categories are: $B_{x(t)}$ refers to the extracted biomass of specific material *x* in specific year *t*, $F_{x(t)}$ is the amount of extracted fossil fuel *x* in specific year *t*, $M_{x(t)}$ refers to the extracted metal ores and industrial minerals type *x*, and while the $C_{x(t)}$ is amount of extracted construction minerals *x* in specific year *t*.

3.2.2 Direct material input (DMI)

DMI refers to the direct input of materials into the Philippine economy. It is estimated as equivalent to the sum of amount of domestically extracted materials and the imported materials per category as shown in the equation below:

$$DMI_{(t)} = DE_{(t)} + \sum_x^y I_{x(t)}$$

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In this equation, the $DMI_{(t)}$ is domestic inputs at specific year t, $DE_{(t)}$ is the domestic extraction at specific year t, and I_x is amount of imports x at that specific year t. Variety of imports material types varying from x to y are taken into account.

3.2.3 Domestic material consumption (DMC)

DMC refers to the amount of materials remained and utilized in the Philippine economy. It is calculated by subtracting the amount of exported materials to the amount of DMI as shown in the equation below.

$$DMC_{(t)} = DMI_{(t)} - \sum_x^y E_{x(t)}$$

$$DMC_{(t)} = DMI_{(t)} \text{-} \sum_x^y E_{x(t)}$$

$$DMC_{(t)} = DMI_{(t)} \text{-} \sum_x^y E_{x(t)}$$

The $DMC_{(t)}$ stands for direct material consumption at year t and $E_{x(t)}$ refers amount of exports type x at year t. Same as imports, all export types from x to y are taken into consideration in detail.

3.2.4 Physical trade balance (PTB)

PTB indicates the physical trade surplus or deficit of an economy. It is estimated by subtracting the quantity of the physical imports $I_{(t)}$ from the quantity of the physical exports $E_{(t)}$ in year t as shown in the equation below.

$$PTB_{(t)} = I_{(t)} - E_{(t)}$$

$$PTB_{(t)} = I_{(t)} \text{-} E_{(t)} PTB_{(t)} = I_{(t)} \text{-} E_{(t)}$$

3.3 Analysis of Data

The indicators of EW-MFA depict the physical magnitudes of the economy and show the general and overview of the quantitative picture to describe the material flows in the light of economic activities (Xu and Zhang, 2007). Using these indicators, further analysis can be done to elucidate the complex relationships between the environment and socio-economic systems.

3.3.1 IPAT Analysis: Drivers of Resource Consumption in the Philippines

This study utilized the method of IPAT model adapted as by Eurostat (2002), where the environmental impact (I) is the product of population (P), affluence (A), and technology (T), substituting the DMC to represent the environmental impact (Xu and Zhang, 2007). The driving factors of the resource consumption and economic growth in the Philippines for 25 years is determined with the IPAT expressed as follows,

$$DMC = \Delta P \times \frac{GDP}{P} \times \frac{DMC}{GDP}$$

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where *I* corresponds to the *DMC*, *P* is *Population*, *A* refers to the *GDP/capita*, and *T* denotes the *Material Intensity, MI* or equivalent to the *DMC/GDP*.

3.3.2 Decoupling Analysis

Based on the method introduced by the OECD (2002), decoupling factor is calculated as follows:

Decoupling factor (D_f) = $$1 - \frac{(EP/_{DF})end\ of\ period}{(EP/_{DF})start\ of\ period}$$

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where D_f refers to the decoupling factor, EP refers is the environmental pressures, and DF is the driving force. In this study, resource consumption or DMC is used to represent environmental pressure and GDP represents the economic driving force and the interpretation of the calculated decoupling factor is based on the table below (Wang et. al, 2013).

Table 3. Decoupling factors and corresponding degree of decoupling

Degrees of Decoupling	Decoupling factor, D_f
Absolute decoupling	$D_f \geq 1$
Relative decoupling	$0 < D_f < 1$
Non-decoupling	$D_f \leq 0$

4. Results and Analysis of Data

4.1 Indicators of EW-MFA in the Philippines

4.1.1 Domestic Extraction

Figure 1 shows the material domestic extraction (DE) in Philippines from 1985 to 2010. The quantity of DE was more than doubled in 25 years, from 116 million tonnes (Mt) in 1985 to 335 Mt 2010. Biomass and construction material were the two most extracted materials in the Philippines comprising 95% in 1985 and 90% in 2010, respectively. The amount of biomass grew from 94 Mt in 1985 to 157 Mt in 2010. The active construction activities in the economy resulted to the increase in the extraction of construction minerals from 17 Mt in 1985 to 146 Mt in 2010. In 1997, the significant increase in the amount of construction minerals was accounted to the sudden increase of sand and gravel extraction from an amount of 31 Mt in 1996 to 77 Mt in 1997, same year at which the construction industry grew to 21% (MTPDP, 2010), the highest growth from 2004 to 2010. Sand and gravel are the basic minerals utilized in the infrastructures required to support the needs of the growing economy of the Philippines.

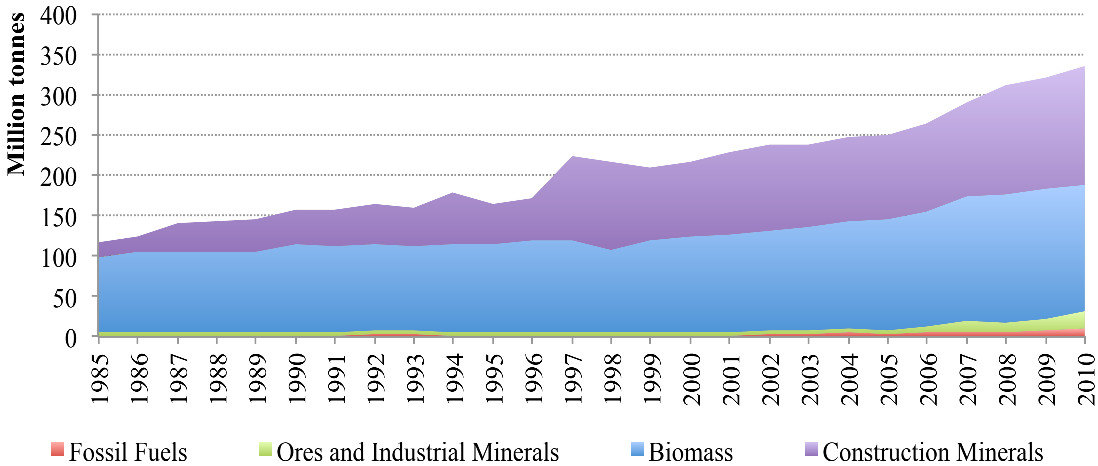

Figure 1. Domestic extraction in the Philippine economy from 1985 to 2010

4.1.2 Direct Material Input

Figure 2 illustrates the trends on the direct material input (DMI) in terms of the four major material types. DMI was estimated from the sum of DE and the quantity of import. The DMI doubled from 135 Mt in 1985 to 379 Mt in 2010. The biomass remained to be the highest material input for the 25-year period, comprising 44% of DMI. Both the input of fossil fuels and biomass were more than doubled, from 16 Mt and 96 Mt in 1985 to 32 Mt and 169 Mt in 2010, respectively. The ores and industrial materials increased from 6 Mt in 1985 to 29 Mt in 2010. The DMI of construction minerals rose significantly from 17 Mt in 1985 to 148 Mt in 2010. The majority of direct material input was attributed by the domestic extraction (from 86% in 1985 to 89% in 2010), while the share of imports in DMI varied from 9% to 17% in a 25-year period.

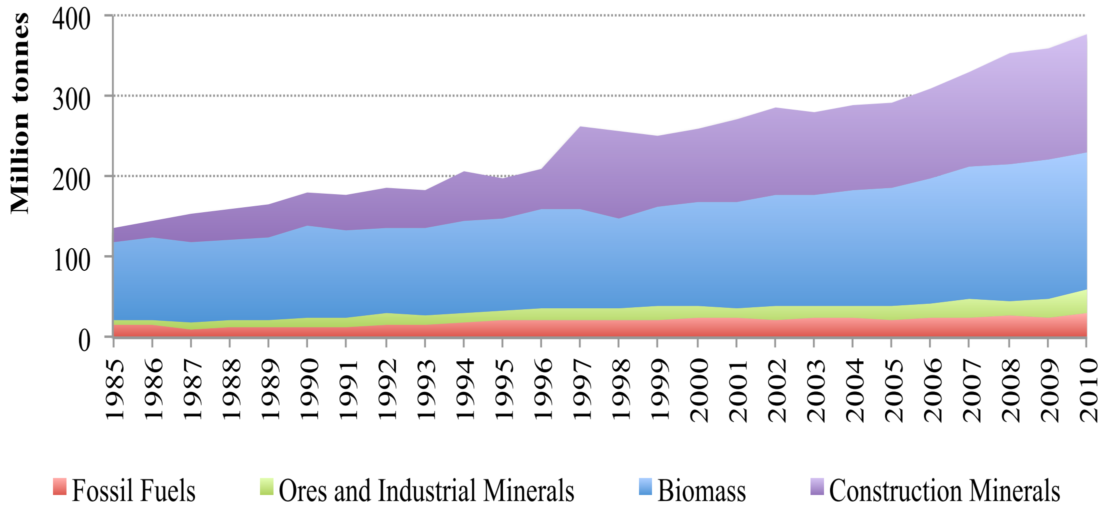

Figure 2. Direct material input in the Philippines from 1985 to 2010

4.1.3 Domestic Material Consumption

The domestic material consumption (DMC) measured in this study refers to the natural materials (without water and air) obtained from the Philippine environment, used and remained in economy after the exported materials were deducted, and the quantity of the imported materials were added. The amount of the consumed resources in the Philippine economy increased from 128 Mt in 1985 to 353 Mt in 2010 as shown in Figure 3. The biomass had 72% share (92 Mt) and construction minerals had 13% (17 Mt) share of DMC in 1985. In 2010, however, the share of construction minerals rose to 42% (148 Mt), a share almost equivalent to biomass with 43% (152 Mt). While the ores and industrial mineral and fossil fuels grew continuously in amount, it remained within 15% of the annual DMC.

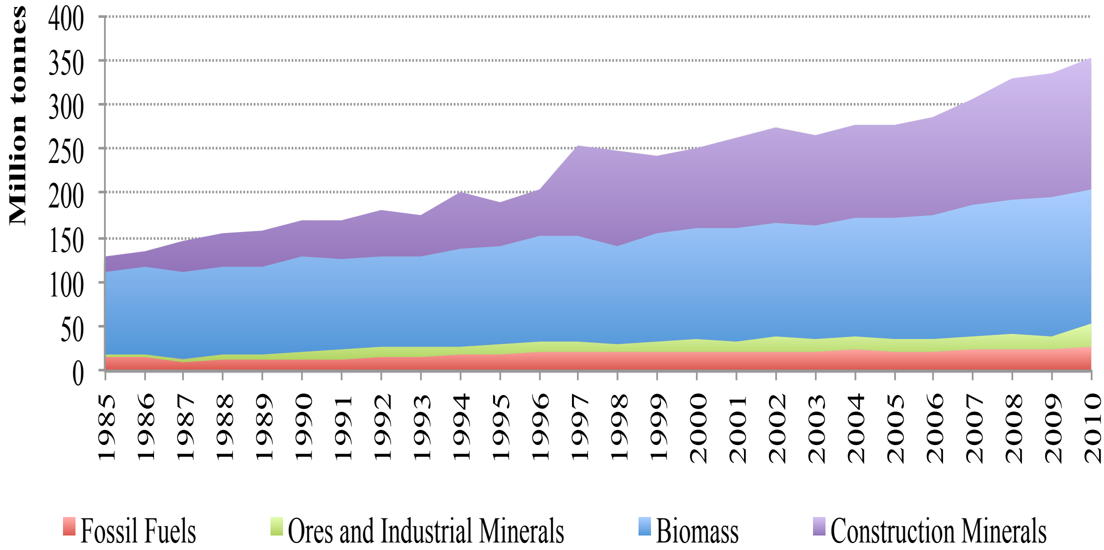

Figure 3. Domestic material consumption in the Philippines from 1985 to 2010

The quantity of biomass remained to be the significant materials in the Philippine economy, but the quantity and the share of construction minerals in DMC began to increase in 1997. The growing amount of construction minerals shows the increasing important role of the construction industry in the Philippine economy. It is also indicated by the corresponding growth in the GDP in the construction industry with 10.5 % growth in 2010. The increasing quantity of construction minerals also shows that the Philippine economy is moving towards the increase dependence on the nonrenewable materials rather than the renewable materials or the biomass.

Such trends of material composition where the mostly consume materials are biomass and non-metallic minerals are the common characteristic of the low income developing countries while trend in high income developing and developed countries have high share of fossil fuels and metal ores due to shifting demands and consumption pattern and growing industrial demand (Giljum et. al, 2010).

The per capita DMC also increased slightly from 2.37 tonnes in 1985 to 3.78 tonnes in 2010. Figure 4 shows the material consumption per capita broken into major material categories in the Philippines. The higher per capita consumption of biomass is due to the significant agricultural and forestry sector in the Philippines.

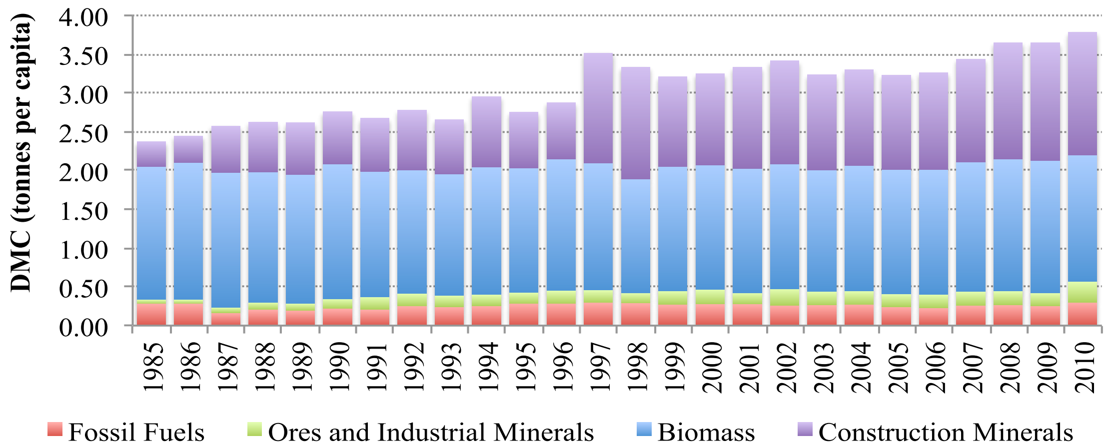

Figure 4. Trends on domestic material consumption (DMC) per capita in Philippines from 1985 to 2010

4.1.5 Physical Trade Balance

The PTB expresses the physical trade surplus or deficit of an economy. The surplus or a positive PTB value refers to the net import of biophysical resources and deficit or the negative PTB value refers to the net exports. PTB is estimated based on the amount of imports less than the exports. The quantity the imports, exports and PTB are shown in Figure 5. Both imported and exported materials increased significantly in 25 years, with the amount of imported material remained greater than the exported material. Imported materials rose from 19 Mt in 1985 to 43 Mt in 2010 while the exported materials rose from 7 Mt in 1985 to 26 Mt in 2010.

External trade is important to a developing economy like Philippines. It does not only open the agricultural products and manufactured goods of the Philippines to open market but the exchange of materials and open trade bring the needed materials and equipment to the country that are durable and necessary to propel industries into further productivity. Biomass consist of agricultural products comprised the highest amount of the exported materials while the Philippines continues to be dependent on the imported fossil fuels to supply the energy needs.

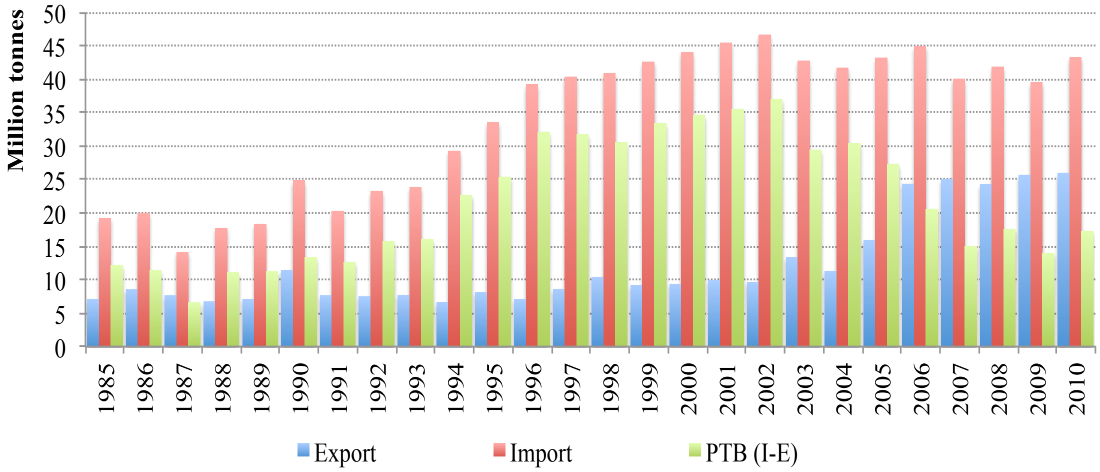

Figure 5. The trends on import, export and physical trade balance in the Philippines from 1985 to 2010

4.2 Drivers of Resource Consumption and Resource Intensity in the Philippines

With the use of IPAT analysis, the drivers of consumption in the Philippines were determined in terms of the three important factors namely; population, affluence (GDP/capita), and technology expressed as material intensity (DMC/GDP). The 25- year period was divided in five equal periods to determine the drivers of resource consumption for every period as shown in the Table 4.

Table 4. Driving forces of the resource consumption in the Philippines from 1985 to 2010

Period	ΔDMC$_{(I)}$(%)	ΔDMC (Mt)	ΔP (%)	ΔA (%)	$\Delta MI_{(T)}$ (%)	Share Contribution Using Log Transformation		
						P (%)	A (%)	MI$_{(T)}$(%)
1985-1990	26	39.25	13	10	3	51	39	10
1990-1995	11	20.67	12	-1	1	103	-8	5
1995-2000	26	57.26	11	7	8	42	25	32
2000-2005	18	48.99	10	12	-5	57	69	-26
2005-2010	19	61.08	9	15	-6	47	83	-30

Note: DMC domestic material consumption, P population, A affluence, T technology = MI, Material Intensity

The change in the resource consumption from 1985 to 2000 was driven by the population growth, where the annual population growth rate in the Philippines from 1980 to 2000 was 2.35% and slightly decreased to 2.04% from 2000 to 2007, while the growth of the Philippine economy made the affluence to be the major driver of resource consumption in the last 10-year period of the study (2000 – 2010).

The Philippine economy grew at a respectable pace over the period of 2001 to 2004, with 3 percent in 2001 to 6.7 percent in the first semester of 2004, and expanded at its fastest rate in three decades in 2007, at 7.1% GDP growth. The global economic crisis in 2008 manifested its effect in the Philippines with the decline of GDP growth to 1.1% in 2009 but recovered and rebound to 7.35% in 2010. This growth of economy, driven the resource consumption showing that there is increasing part of the population who are improving in their lifestyles. Those who can afford to buy not only the basic daily needs but enjoy other material things and quality services also demand and consumed greater quantity resources.

The T (as expressed by material intensity measured from amount of material consumed per GDP (DMC/GDP) shows modest decrease in 2000 to 2010 as indicated by the decreasing values of -5% and -6%, respectively, but became negligible due to the increased in P and A. The material intensity needs to improve in a way that is related to the growth of GDP to compensate the extractive pressures of socio-economic activities to the environment. The material intensity is inversely related to the material efficiency, thus decreasing material intensity values means increasing efficiency in the consumption of the material or the resources.

The last decade of this study shows decrease in the material intensity showing the emerging awareness in the Philippine socio-economic system on the importance of efficiency on resource consumption. This awareness should be supported and improved with institutional framework, adequate policies and implementation in the Philippines that will strengthen the resource efficiency both in the important sectors such as agriculture fishery and industries towards the goal of sustained economic development.

4.3 Decoupling of Resource Consumption and Economic Growth

In the decoupling analysis, it is aimed to depict the mutual relationship of the economic driving force and environmental pressure. The environmental pressure in this research is represented by the resource consumption expressed as DMC, while the gross domestic product (GDP) is taken as the proxy for the quality of life and as economic driving force. Similar to the IPAT analysis, the decoupling analysis was carried out in five equal years in the 25-year period of the study. Figure 6 shows the decoupling trend on the resource consumption and economic growth from 1985 to 2010.

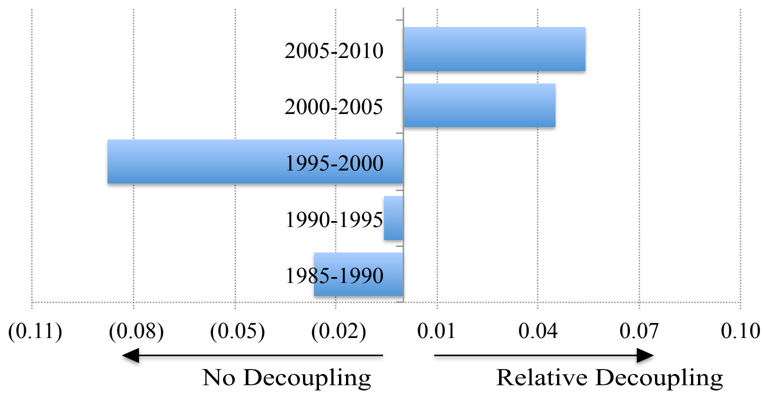

Figure 6. Decoupling of resource consumption (DMC) from economic growth (GDP) in the Philippines from 1985 to 2010

Based on this analysis, no decoupling occurred during the period of 1985 to 2000, as shown by the negative values of the decoupling factors. This indicates that for this period the growth in the resource consumption or DMC (188%) is higher than that of the GDP (167%). Relative decoupling occurred in the periods of 2000 to 2010 as shown by the positive values of the decoupling factors. Relative decoupling occurs when the growth rate of resource consumption (DMC) is lower than the growth rate of GDP. From 2000 to 2010, the GDP grew by 156% while the DMC grew at a lower percentage of 144%.

The relative decoupling in the Philippines is quite modest since the higher the value of decoupling factor ($0 \leq D_f \leq 1$), the greater the degree at which the DMC grows at significantly lower rate than that of the GDP. Nevertheless, it is important to recognize the beginning of the improvement in terms of resource consumption relative to the economic growth in the Philippines. While the Philippines continuously battles with the issues of poverty and inclusive economic growth and where resource extractive industries become the resort of economic growth, it is also important to look into other sectors to improved and be a catalyst to economic development. At the period at which the economy is expanding, the demand on materials such as construction minerals and fossil fuel are expected to grow at a rapid rate, the Philippine government should formulate policies that would develop other sectors and would balance the demands from industrial sectors that would include the promoting the growth from the service sectors such as tourism activities.

5. Conclusion and Recommendations for Future Studies

This research illustrated the trends in the resource consumption, the flow of materials and the economic growth in the Philippines from 1985 to 2010. The extraction of the natural resources (DE) in the Philippines increased to 289% along with the resource consumption (DMC) to 275% in the twenty-five year period of this study, while the economic growth (GD) grew at a lower phase at 266%. The socio-economic system is on transition from the renewable material consumption (biomass) in 1985 to the nonrenewable material consumption (construction mineral) in 2010. While this phenomenon is the usual trend in the growing economies, it is important for Philippines should take a thorough look to improve the current resource consumption with the developing patterns.

The resource consumption was driven by the population growth in 1985 to 2000, while the growing affluence became apparent in 2000 to 2010. The material intensity showed a modest decrease in 2000 to 2010. However, there is a need to improve the material intensity in the utilization of the natural resources. In the analysis of decoupling of resource consumption from economic indicator (GDP) showed relative decoupling from 2000 to 2010.

This study on the physical metabolism of the Philippines socio-economic system suggests that while the country is at the early stage of economic growth and with abundance of natural resources, the resource management should be geared towards resource efficiency to maximize the productivity in the utilization of these nonrenewable resources. Strong institutional framework, develop policies that would achieve the sustainable development in the Philippines.

The future research studies on the output indicators of EW-MFA and the quantifying the quantity of hidden material flow associated with the domestic extraction in the Philippines should be taken into considerations.

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References

[1] A. Adriaanse, S. Bringezu, A. Hammond, Y. Moriguchi, E. Rodenburg, D. Rogich, H. Schutz (1997). *Resource Flows: The Material Basic of Industrial Economies* (World Resource Institute,

[2] Bringezu, S., Schutz, H., Steger, S. and Baudisch, J. (2004). International Comparison of Resource use and its relation to economic growth, the development of total material requirement, direct material inputs and hidden flows and the structure of TMR. Ecological Economics 51. pp 97-124.

[3] Bringezu S., Schutz H., Moll, S. (2003). Rationale for the Interpretation of Economy-wide Materials Flow Analysis and Derived Indicators. Journal of Industrial Ecology. Pp. 43 – 64.

[4] CountryStat Philippines. Bureau of Agricultural Statistics. (http://www.countrystat.bas.gov.ph). Accessed on 27 September 2013. Accessed on 27 September 2013.

[5] Eurostat. (2001) Economy-wide Material Flow Accounts and Derived Indicators: A Methodological Guide. Luxembourg.

[6] Eurostat. (2009) Economy-wide Material Flow Accounts and Derived Indicators: A Methodological Guide. Luxembourg.

[7] Giljum S., Dittrich M, Bringezu S, Polzin C, Lutter S. (2010). Resource Use and Resource Productivity in Asia. Trends Over the Past 25 Years. SERI Working Paper No 11. Sustainable Europe Research Institute (SERI). Vienna, Austria.

[8] Giljum, S. (2004) Trade, material flows and economic development in the South: The example of Chile. Journal of Industrial Ecology 8(1-2): 241-261.

[9] Hashimoto, S., S. Matsui, Y. Matsuno, K. Nansai, S. Murakami, and Y. Moriguchi. 2008. What factors have changed Japanese resource productivity? A decomposition analysis for 1995–2002. Journal of Industrial Ecology 12(5–6): 657–668.

[10] Kovanda, J., T. Hak, and J. Weinzettel. 2010. Material flow indicators in the Czech Republic in light of the Accession to the European Union. Journal of Industrial Ecology 14(4): 650–665.

[11] Kovanda J. Hak T. (2007) What are the possibilities for graphical presentation of decoupling? An example of economy-wide material flow indicators in the Czech Republic. Ecological Indicators 7. 123–132

[12] Matthews, E. Amann, C. Bringezu, S. Fischer-Kowalski, M. Huttler, W. Kleijn, R. Moriguchi, Y. Ottke, C. Rodenburg, E. Rogich, D. Schandl, H. Schutz, H. vander Voet, E. and Weisz, H. (2000). The Weight of Nations: Material Outflows from Industrial Economies. World Resource Institute.

[13] Maung K.N., Komatsu T., Martinico-Perez M.G., Lwin C. M., Mohammad S., Sugimoto K., Okuoka K. , Murakami S., Tanikawa H. (2014). Assessment of Economy-wide Material Flow Accounts and its Implications: Comparative Case Studies in Myanmar, Bangladesh and Philippines. Journal of Environmental Information Science, pp. 51-60, Vol.42, No.5.

[14] Maung K.N., Martinico-Perez M.G., Komatsu T., Mohammad S., Murakami S., Tanikawa H. (2014). Comparative Studies on Driving Factors of Resource Flow in Myanmar, the Philippines and Bangladesh. Journal of Environmental Economics and Policy Studies, Vol. 16, No. 2.

[15] Medium Term Philippine Development Plan 2011 – 2016. National Economic and Development Authority. www.neda.gov.ph. Accessed on 18 March 2014.

[16] OECD. (2002). Indicators to Measure Decoupling of Environmental Pressure from Economic Growth.

[17] Philippine Statistical Yearbook (various years). National Statistical Coordination Board. Philippines.

[18] SERI, GLOBAL 2000. Friends of Earth Europe. 2009. Overconsumption? Our use of the world's natural resources. Vienna & Brussels.

[19] Schandl, H. and J. West. 2010. Resource use and resource efficiency in the Asia–Pacific region. Global Environmental Change 20(4): 636–647.

[20] Schandl, H. and M. Turner. 2009. The dematerialization potential of the Australian economy. Journal of Industrial Ecology 13(6): 863–880.

[21] United Nations Environmental Programme. (2013) Recent trends in Material Flows and Resource Productivity in Asia and the Pacific, Thailand.

[22] Wang, H., Hashimoto, S., Moriguchi, Y., Yue, Q., and Lu, Z. Resource use in growing China: Past trends, influence factors and future demand. Journal of Industrial Ecology. 2012, 16(4): 481–492.

[23] Wang, H. Hashimoto, S. Yue Q. Moriguchi Y, Lu, Z. (2013).Decoupling Analysis of Four Selected Countries: China, Russia, Japan, and the United States during 2000 – 2007. Journal of Industrial Ecology 17 (4). 618 – 628.

[24] World Development Indicators. (2013) http://data.worldbank.org/indicator. Accessed in 9/11/2013.

[25] WWF, Zoological Society of London, Global Footprint Network. 2008. Living Planet Report 2008. WWF, Gland, Switzerland.

[26] Xu, M. and Zhang, T. (2007). Material Flows and Economic Growth in Developing China. Journal of Industrial Ecology, No. 11(1), pp. 121-140.

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Surveying Historic Buildings: Valuing Sustainability in Places of Worship

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Abstract:

Historic buildings contribute positively to all aspects of sustainable development. They are more than an environmental and cultural asset; they are an important driver for economic development and delivering social objectives. In the first instance this paper looks at the factors that need to be considered in order to assess the sustainable performance of listed buildings. There is an increasing awareness of the necessity of balancing comfort with energy efficiency. In order to be sustainable historic edifices, including places of worship – which account for a large part of the cultural heritage in the UK– need to willing to adapt to modern comfort requirements but the question is how to do so without risking damaging the historic fabric and exactly how far it is right to adapt these structures at all rather than adjust our ideas of comfort. Historic buildings provide particularly difficult challenges to manage environmentally both because alterations have to avoid destroying the historic character of the building and because changes in the internal environment can easily have adverse effects on that historic fabric. The results of detailed survey of four case-studies, including monitoring, and building thermal simulation and comfort surveys applied to historic church buildings are used here to generate conclusions on the thermal efficiency, performance and risks associated with changing micro-climatic conditions of places of worship. This paper suggests broadening existing sustainability criteria for such edifices in order to include the wider range of factors that affect sustainability in the historic built environment.

Keywords: historic buildings, thermal comfort, sustainability, conservation, energy

Introduction

Historic buildings by definition consist of structural elements and artworks that are uniquely valuable and laws are formulated in most countries to afford them protection against demolition. However, the rising expectations of thermal comfort constitute an additional threat to the preservation of these edifices (Camuffo et al., 2007). Even in the heritage sector, the needs of modern society cannot be entirely ignored. And to a certain extent it can be argued that the structural materials and elements that make up all existing buildings, including those of historical importance, which constitute natural resources in themselves, should be preserved where possible to achieve sustainability (Meryman, 2005).

Improving the performance of the building envelope is often the first action to be considered when starting any sustainable retrofit of a building. In the modern structures this is typically achieved by insulating, sealing and draught-proofing the building envelope, which reduces heat losses in walls, ground floors, roofs and through loose windows fittings. However, the materials that make up or are found in older buildings require higher rates of ventilation and much of this required ventilation was provided in the past by fortuitous air leakage- the buildings' "leakiness" (Heritage, 2008). It has become increasingly apparent that sealing and draught-proofing historic buildings can cause significant deterioration of the internal fabric and the artifacts they contain and can also have a negative impact on indoor air quality and the occupants' health. This research paper looks at the environmental performance of historic churches, whose construction typology - high ceilings, massive un-insulated masonry walls, decorative finishes, etc. - provides particularly difficult environmental challenges. It provides key insights into sustainability in the historic built environment and the factors contributing to the sustainability of historic structures; it highlights and presents a review of the most significant issues of revising sustainability rating systems in order to include the whole range of factors that affect sustainability in the historic built environment.

Sustainability, Climate Change And Conservation

Conservation and sustainability are related in a broader ecological sense (Rodwell, 2007). English Heritage's "Regeneration and the Historic Environment Heritage as a catalyst for better social and economic regeneration" (2005) highlights the benefits of using existing buildings rather than constructing new ones. In the words of another paper: "The greenest building is the one that's already built" (National Park Service. U.S. Department of the interior, website, 2012). One important reason for retaining any exitsing building including those of histroic importance is that any new building will involve considerable embodied energy (Jackson, 2005). The carbon released in building construction has already been long expended in an existing building. Reusing buildings limits the need for new building materials and reduces the structural waste from demolition work (English Hertiage, 2005). At the same time, conservation is considered to be the most cost-effective form of preserving energy in the built environment, since it appreciates the value of existing structures and thus embodied energy (Sedovic and Gotthelf, 2011).

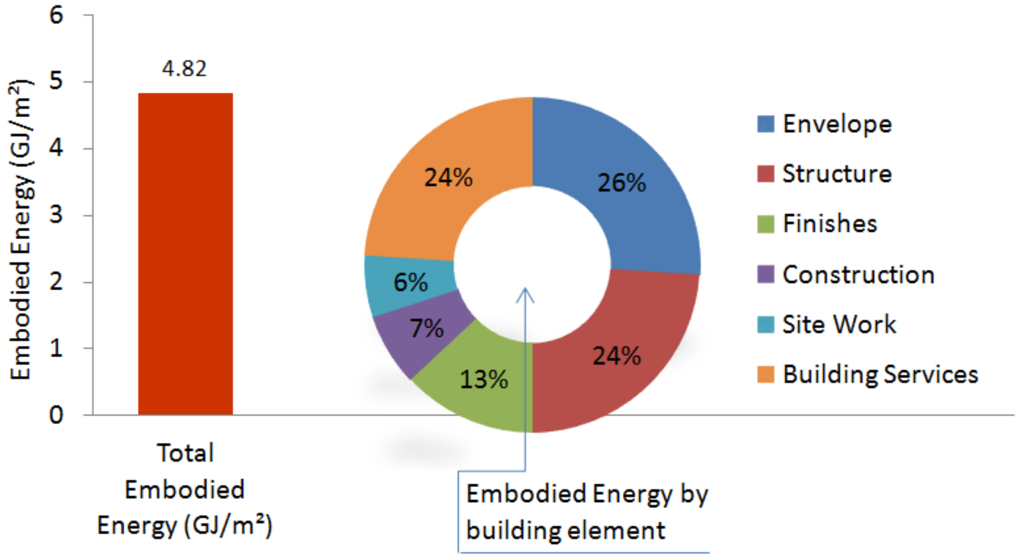

Figure 1 Embodied energy- note that 24% spent wasted on buildings services, a figure than can be substantially reduced by passive energy design
(Cole and Kernan, 1996).

Although, the majority of historic buildings have been constructed with local materials which tend to enclose low embodied energy, the total amount of energy possessed by both materials and the labour to construct the buildings is enormous (Figure 1) (Sedovic, 2003).

Sustainability needs to be seen in its broader sense and not just in terms of carbon emissions (Technical Preservation Services, 2004). There are economic and social aspects of sustainability. On the social level, the sense of *place* is often dependent on the retention of key buildings and landscapes. In England older buildings generally have a greater economic value than new ones of similar uses. Areas with a rich historic legacy have been show to have strong senses of local identity, and historic continuity is an important local educational resource. Historic buildings and other historic assets of urban environment promote community spirit and are often selected as places to host local social events (wedding, funerals, celebrations etc). Moreover historic buildings provdie a physical record of the past, the destruction of which reduces our knowledge irreversibly. Few historic buidlings used much energy for heating or lighting when originally constructed. Where they are inefficent it is modern adapttations have made them so. In the past levels of comfort expected of building were far lower than today. Extensive research has shown that historic buildings can be more environmentally sustainable and their environmental performance can be, as good as, new-build projects (Pickard, 2004). On the economic side, conservation and revival of historic environment creates jobs and thus assists the growth of local economies (English Heritage, 2002) and there is no doubt that an environment of high quality positively affects the performance of any business or community activities. However any scheme needs to be aware of the risks of additions to historic building. It is not simply a matter of adding heating to existing buildings. Siome heating can even be beneficial in certain climates, but poorly-designed heating or cooling systems can cause deterioration to fabric and artworks, as they cause variations of temperature and humidity beyond the limits required for conservation (Curteis, 2008).

Sustainability And Conservation

Historic environment conservation is closely connected to sustainable development and regeneration. In the UK, government statements praise the relationship between the historic environment sector and sustainability (Pickard, 2004). It is recognised that a building can be valuable simply because it represents the social and cultural attitudes of local people. Conservation needs to aim at preserving the character and fabric of the historic building while meeting the needs of people who use them (Pearce, 1989). J. Douglas in his book *Building adaptation* (2002) goes further, suggesting that all conservation work should be combined with regeneration work to improve people's lives in ways that include the quality of local environment. English Heritage has long stressed that existing structures can be adapted to modern needs when required. Indeed there are countless examples where this has been carried out. Sensible alterations or the addition of existing buildings contribute to the sustainability of the urban environment as this can offer people a sense of the familiar along with the excitement for the new (English Hertiage, 2005). Harvey (1972) warns however that it is difficult to decide how far it is possible to alter a historic building without losing its architectural and historic qualities. In all historic buildings including church buildings which are the focus of this paper, special attention to building requirements and implementation of sustainable measures is essential. Places of worship are recognised to constitute a unique type of building and thus normal conservation or environmental design methods recommended for towns and other traditional structures are often not applicable to them (DEFRA, 2009).

Environmental Performance of Historic Structures:
The Case of English Churches

Churches constitute a signifcant part of the heritage of Western Europe. Whatever their size and religion, from cathedrals to chapels, churches in the UK have always been seen as vitally important by the majority of locals, congregations and visitors alike (Taylor, 2010). Unfortunately over the last few decades many churches in the UK been abandoned (Bird, 1959). In England congretgations have been falling and clergy seeking to expand them are often qucik to blame cold and draughty churches. Most historic churches remain in use for worship but with aging and dwindling congregations. Worship is churches' primary and main purpose, and as a rule historic buildings are best used for their intended purpose. Alternative (conversion to housing, offices etc) tend to be espcially damaging to the special architectural or historic interest of the building and thus not always a sustainable choice (Kelleher, 2003).

Securing sustainability of church buildings therefore means maintaining the building structure and contents and while achieving a welcoming environmental conditions for participants. Ecclesiastical buildings are challenging case studies; given that churches represent a large part of the historic built environment in the UK (Over 30,000 churches are listed in the UK, while Church of England is caring for over 13,000 listed places of worship). As energy costs increase and congregations reduce cutting energy use is a necessary aim for the church. On a smaller scale, church buildings also pose particular challenges to achieve an environmentally sustainable performance because they are complex structures; their large volume creates additional difficulties in managing heating and air movement internally to achieve satisfactory comfort conditions; being occupied infrequently sets hurdles to the decision-making of installation of mechanical equipment and in parallel achieve energy conservation and acceptable comfort; and lastly as they are often buildings whose preservation is mandated by law any environmental adaptation needs to be done with the minimum interruption to physical fabric and contents.

Comparative Environmental Performance ff Case-Studies

This study focuses on four case studies, which have been used to test and challenge current thinking on the performance of specific heating methods with regards to building behaviour and formation of specific microclimatic conditions; and the on-site measured values of Temperature and Relative Humidity. Among other conclusions, the research has shown that long-term monitoring can be a successfully employed approach for analysing the microclimate of historic buildings and churches in particular. However, the identification of any thermal stratification inside the enormous volume of church buildings is particularly difficult due to access limitations. A plethora of factors may affect the environmental conditions at the upper levels of the building, such as intermittent occupancy, non-specific schedule for windows and doors opening, instantaneous operation of heating or even occasional failure of the building envelope.

It is important to remember that in England most older churches were originally constructed without any heating provision, heating being uncommon until the late nineteenth century. Retaining the original microclimate conditions by avoiding changing heating, ventilation or other mechanical service operations, maintains a state of equilibrium is achieved between the moisture in the building structure and that in the air (Curteis, 2004). Among all possible influences, heating has been proven to affect the church microclimate most intensively, especially in the case of heating use for thermal comfort provision for short time periods which usually causes environmental distress to the building structure and is likely to become the source of deterioration of plaster, stonework and other historic material.

The following study is based on monitoring of Great St Mary's, St Botolph's, All Saints church and Queens' College chapel in Cambridge, UK, which employ representative heating methods and mechanical equipment. Each case employs a different combination of heating system and strategy that causes particular variations in the building environmental response.

Despite the different methods employed, the Temperature per month in all case studies shows remarkably homogenous conditions at both the lower occupied levels and in upper parts of the buildings. (Figure 2) The buildings with constant heating strategies (Great St Mary's and All Saints) maintain rather high temperature conditions (average 15°C throughout the year). The intermittently-operated localised heating system in St Botolph's church has little influence on the internal microclimate of the church which generally follows the fluctuation patterns of the external conditions; however the building still acts as a buffer zone that maintains the indoor Temperature at approximately 5°C above outdoor Temperature level. Furthermore the lack of heating at the generally heated Queens' College chapel during out-of-term time within the heating period provides significant differences in the thermal conditions in the chapel.

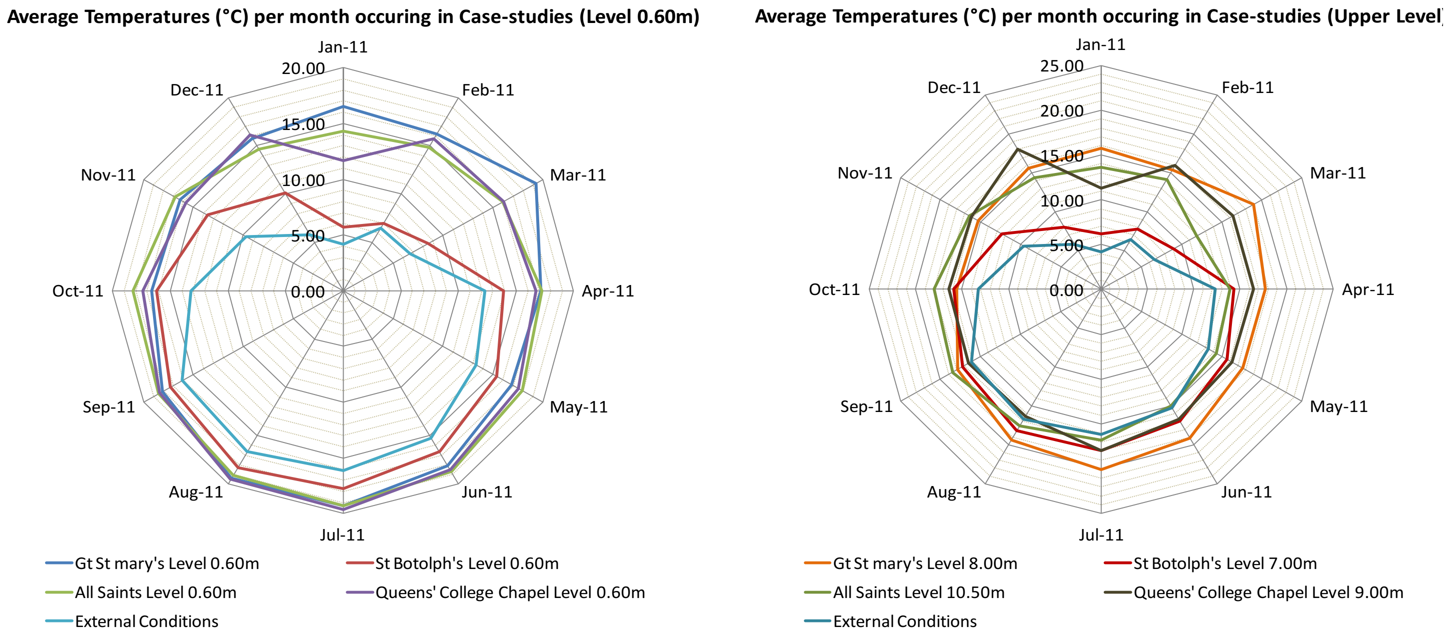

Figure 2: Average Temperature per month occurring on the occupancy level and upper building part in all case-studies.

Detailed analysis provides more interesting results. The regressed temperature against relative Humidity values on a typical Sunday when services took place in all case-studies, show concentrated values at the occupied level in all case studies. (Figure 3) However the regression analysis reveals more varied results in the upper parts of case-studies, most significantly at St Botolph's church which is heated intermittently. The heating systems used in three out of four cases (Gt St Mary's, All Saints and Queens' college chapel) produce their effect by radiant means (and convective means in some auxiliary spaces of Gt St Mary's) which do not introduce any further particles into the internal microclimate. However, in the case of St Botolph's church, which is heated only for limited hours per week, the church is using both radiant local heating method through heating panels on pews and portable gas flame heaters. The gas heaters are very efficient in producing fast and relatively low cost heat, however they have the huge disadvantage that the main combustion product of Liquid Petroleum Gas (LPG) is water, each 1kg of gas burned producing about 1.5kg water (Curteis, 2004). The result is that using gas heaters in a large church for only one or two hours, causes dramatic rises in absolute humidity, resulting in condensation, immediately after they are turned off. Thus, RH in St Botolph's church fluctuates rapidly compared to other intermittently heated cases, such as Queens' college chapel when the heating is radiant and it operates for much longer periods before it is switched off. This is important because high levels of humidity and particularly condensation, are detrimental to pictures, timber, paintwork and plaster and also, through mould growth, to human health. The conclusion is that general low level constant heating is better for the building. This however is not necessarily the most energy efficient solution, nor the most comfortable.

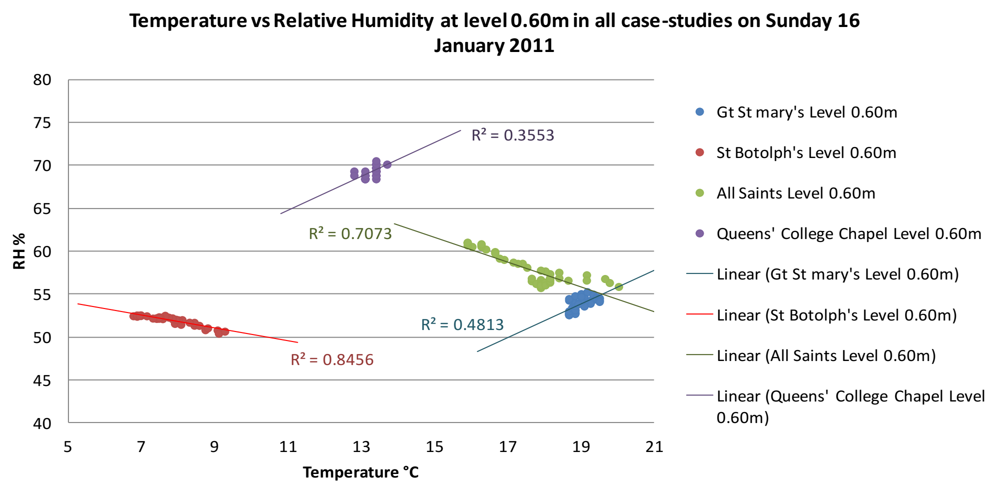

Figure 3: Temperature and RH correlation on occupancy level (0.60m from floor) in case studies during a typical one-day period.

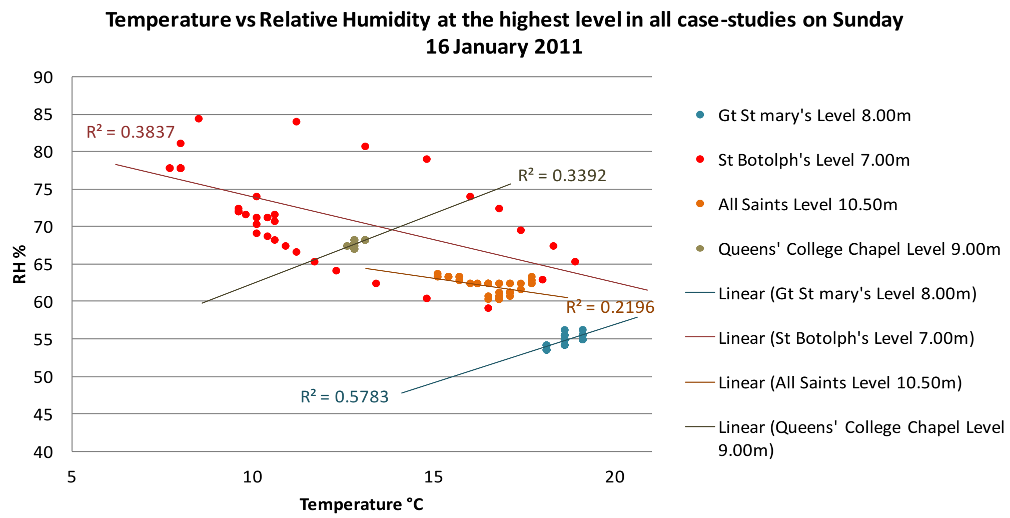

Figure 4: Temperature and RH correlation on upper part of case studies (average of 8 m from floor) during a typical one-day period.

Energy Consumption In Places Of Worship

The energy consumption of a church varies with size, age, heating type, weekly occupancy and the community use of the buildings (CofE, 2008). Managing and reducing energy consumption can have significant benefits for everyone. Reducing energy consumption reduces costs, and helps reduce the volume of harmful greenhouse gases being released into the atmosphere (CofE, 2008). Church of England has undertaken surveys of church halls and other ecclesiastical buildings in order to estimate the energy consumption in its premises with the intention of producing general guidance in due course on energy saving measures. 60 church buildings within the Diocese of London and Westminster were inspected as part of the Church of England's environmental audits during 2009 and 2012. Those series of audits were part of the Diocese of London's response to the church of England's environmental campaign, named "Shrinking the Footprint", which aims to reduce carbon emissions of the whole organisation's premises by 80% by the year 2050 (CofE, 2008). The aforementioned environmental audits examined the churches' energy use and carbon footprint as a result of fuel and water consumption, waste and recycling. It was found that fossil fuels constituted the largest source of carbon dioxide emissions. The survey has also revealed that approximately 43% of churches use natural gas and 21% use oil for space heating. In addition comparison between a rural and urban church revealed that the two types of church varied in terms of energy use patterns. The rural church used the majority of total energy consumed for space heating (79%) and lighting (17%), while the urban church used only 53% of total energy consumption for heating (CofE, 2008). In many cases, in the urban churches, especially the ones that are in constant operation, energy usage can be attributed to other uses (i.e. kitchens, cafés, offices, etc) which made up a considerable percentage of the total energy consumption. Figures 5 and 6 illustrate findings of the survey conducted in a rural and an urban church that hosts community actions.

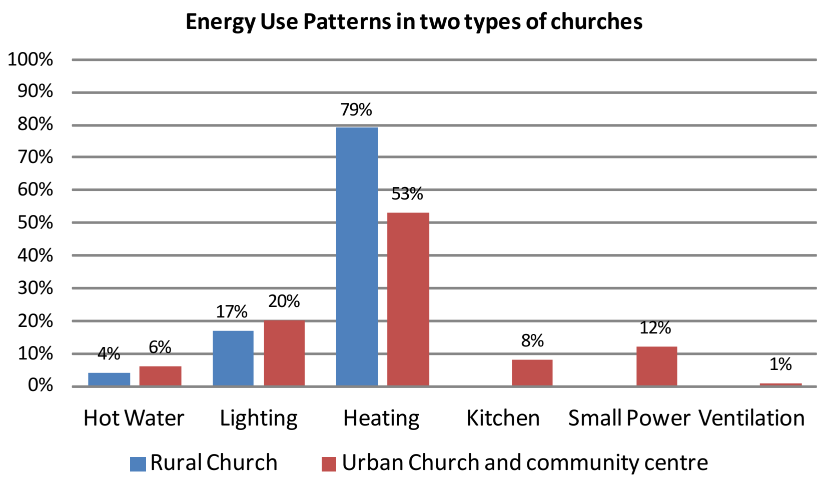

Figure 5 Energy use patterns in a Rural and Urban church.

It is evident that the majority of energy used in both cases can be attributed to space heating. However the average energy consumption of a rural church is estimated to be less than a tenth lower than the annual energy consumption in an urban church. (Figure 3-2) It is clear that occupancy patterns play an important role in church buildings energy use; rural churches have limited occupancy periods compared to urban churches and use almost all the energy they consume for space heating during church services.

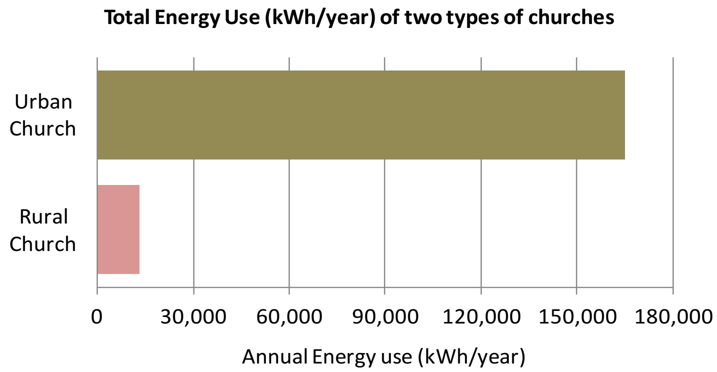

Figure 6 Total Annual Energy use of Rural and Urban church with community use.

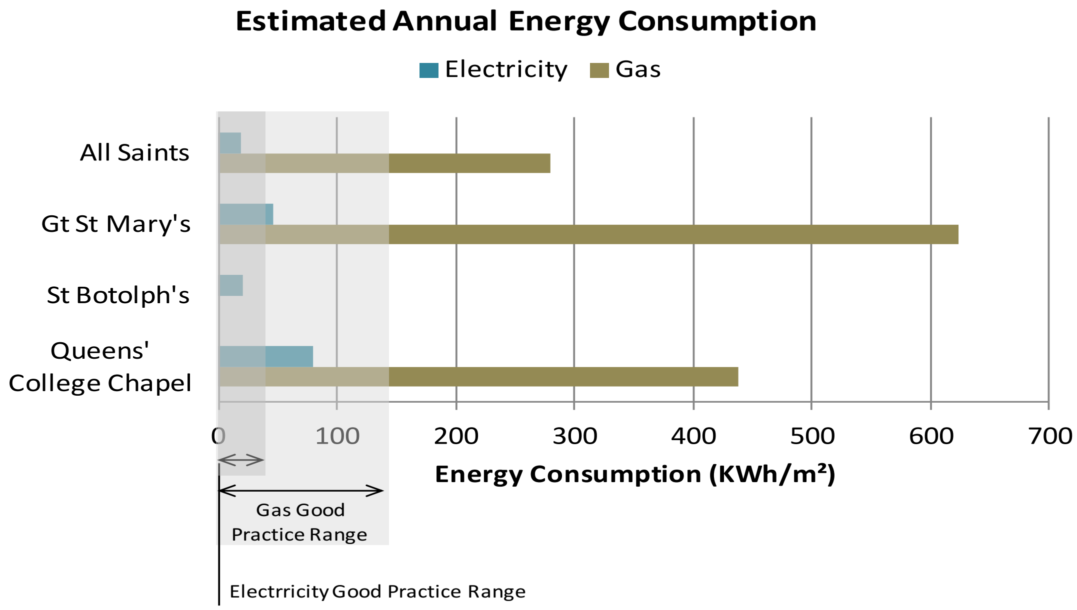

Figure 7: Estimated Annual Energy Consumption in four churches in Cambridge.

Measures for Energy Conservation in Church Buildings

Carbon dioxide emissions from churches arise from a limited number of activities. Mainly emissions come from energy used when heating and lighting a church but at larger sites other activities like hot water generation, kitchen and catering activities and office energy use will also contribute. It should be noted that using energy, whether it is electrical energy or fossil fuels like gas, oil or coal, will generally result in the release of carbon dioxide emissions into the atmosphere (CofE, 2008). Small scale wind generation or solar power are generally not viable for most churches in the UK. Table 1 presents a summary of suggested energy saving actions that church building managers and users could undertake in order to achieve specific potential savings on their utilities bills (see). These measures can be of low, medium or high cost and would include:

- Establishing a schedule for energy conservation by empowering energy saving considerations to building users:
    - Inform and consistently educate users about benefits of building energy conservation and methods of reducing energy demand in their building.
    - Conduct regular monitoring of building energy consumption by either manual meter readings or via installation of specialised monitoring equipment, e.g. energy meters with pulse output transmitters (if affordable). This is the simplest method of energy-monitoring a church without need to install any extra hardware since regular meter

readings and bills are kept to compare performance annually against benchmarks (Diocese of London, 2011).
    - Map the energy use patterns within the building through observation of energy end uses in order to identify activities that use excessive energy.
    - Introduce energy benchmarks to building users and provide them with regular feedback in order to understand the impact of particular activities or behaviours on energy consumption of their church.

- Effective settings and control of heating in churches can save up to 80% of energy use (Diocese of London and Carbon Trust, 2011). Measures to improve heating controls can vary:
    - Adjust temperature set-points to match requirements for heating levels in church environments.
    - Set appropriate time schedule controls to avoid waste of energy during long period when the building is not occupied.
    - Consider creating zones within church building according to use patterns.
    - Take advantage of the high thermal capacity of historic churches thermally heavyweight structure.

- Investing in energy efficient plant equipment and controls can lead to significant reduction of energy demand:
    - Low energy lighting lamp technologies and controls, e.g. Task/Ambient Lighting Schemes.
    - Low energy space heating systems in combination with creation of microenvironments for occupied zones, e.g. Floor-warming, pew heating.
    - Insulation of hot water pipework.

- Although often constrained because of heritage characteristics of church buildings that require conservation, particular fabric improvement options may prove to be robust and offer long term benefits to energy demand reduction:
    - Add insulation where the heritage fabric allows, e.g. roof voids, but ensure ventilation to minimise the risk of condensation.
    - Check completeness and improve the condition and of roof insulation.
    - Improve air tightness through repairing building envelop failures, such as sealing penetrations and joints in walls that may form unwanted air-paths, joints of walls to roofs, cladding panels and where services penetrate.
    - Check and improve condition of windows, grouting seals, closing mechanisms to minimise air leakage paths.
    - Consider high performance glazing for replacements with argon filled voids and special coatings to reduce the U value to less than 2.0 W/m2K including frame.
    - Secondary Glazing with high performing glass thin gap double glazing has been used successfully in heritage building refurbishments.
    - Check seals around doors, repair or replace as necessary.
    - Consider the fitting of draught lobbies to minimise the heat loss through external doors used continuously by public or building occupants.

- Micro generation equipment as soon as it is not visible from important view points and does not damage historic fabric. However, since installation of renewable energy technologies entails high investment costs with long payback periods, Low and Zero Carbon Technologies (LZCT) should be considered once procedural and demand reduction measures have first been put in place. Then LZCT would offer potential for major carbon reductions.

Table 1 Suggested energy conservation action for churches based on sources:(Diocese of London and Carbon Trust, 2011).

Suggested Primary Action	Suggested follow-up options/actions	Potential cost implications	Estimated savings on annual fuel bills (% of total utility cost per annum)
Establish a schedule for energy saving	Inform/educate users about benefits of building energy conservation and methods of reducing energy demand in their building	Zero or low cost	5% - 15%
	Regular monitoring of building energy usage	Zero or low cost	5% - 15%
	Monitoring and mapping of energy use patterns within the building to identify activities that use/waste too much energy	Zero or low cost	5% - 15%
	Provide feedback to building managers and users	Zero or low cost	5% - 15%
Improve heating controls	Check temperature set points	Zero or low cost	5% – 10%
	Check time schedule of controls	Zero or low cost	5% – 10%
	Check the zoning of heating and ventilating systems according to use patterns.	Low or medium cost	10 – 15%
	Take advantage of historic churches' thermal mass properties.	Zero or low cost	10 – 15%
Suggested Primary Action	**Suggested follow-up options/actions**	**Potential cost implications**	**Estimated savings on annual fuel bills (% of total utility cost per annum)**
Energy efficient systems and controls	Low energy lighting	Medium cost	Up to 50%
	Low energy space heating and controls according to occupation patterns	High cost	Up to 20%
	Insulation of hot water pipes.	Low cost	Up to 5%
Fabric improveme nts	Insulate where heritage fabric allows but ensure ventilation to minimise the risk of condensation.	Medium or high cost	Up to 10%
	Improve air tightness to establish better control of air movement through the building.	Medium or high cost	1% - 10%
Low and Zero Carbon Technologies	Photovoltaic Panels: Electricity Production	High cost	Up to 76% reduction of electricity (mains) consumption
	Solar Thermal Panels for Domestic Hot Water (DHW) provision	High cost	Potential for 100% offsetting of gas (mains) use for DHW
	Biomass heating	High cost	Up to 56% reduction in carbon emissions (gas consumption may be 0 if gas boiler is not used as back up to heating and hot water system)
	GSHP (Ground Source Heat Pumps): Space heating	High cost	Up to 34% (GSHP) would displace gas used for heating but with additional electricity use and would have longer payback period than biomass boilers.

Regular meter readings were made in 2010 of the four church buildings in Cambridge in order to estimate the energy consumption per month (Figure 7). The survey was conducted in four representative churches with different types of heating strategies:

- Great St Mary's church, Cambridge: Constant Central (Trench) heating
- St Botolph's church, Cambridge: Intermittent Local (Electric Panels on Pews) heating
- All Saints church, Cambridge: Constant Central heating, Thermostatically controlled to keep the church at conservation temperatures (11.5˚C -12˚C)
- Queens' College Chapel: Central heating with water pipes on windows level.

Queens' college chapel and Great St Mary's church consumed large amounts of gas (m^3/m^2) and electricity (KWh/ m^2) due to regular use, compared to All Saints and St Botolph's church. The case-studies that used gas for heating space consumed much more fuel (KWh/m^2) than the 'good practice' quantity suggested by the benchmark -151KWh/m^2. The electricity consumption per annum seems to be closer to the suggested values (CofE, 2008). St Botoph's has been shown to perform poorly in conservation terms, leaving the question of whether All Saints provides adequate thermal comfort.

Thermal Comfort in Places of Worship

One of the evident purposes of the Building Research & Information special issue 'Comfort in a Lower Carbon Society' (Shove, 2008) was to underscore how cultural and historical context has a significant impact upon the techniques of achieving human comfort deemed appropriate at the time. This undertaking is useful because it challenges assumptions that are often otherwise made about the ambient conditions with which we should provide people when these assumptions could easily lead towards certain undesirable outcomes. Supplying the same immediate environmental conditions to people scattered across the varied local climates around the world would require enormous amounts of energy. The effect of these assumptions might also mean many people could quickly become so used to specific ambient conditions that they turn their backs on the varied benefits that often follow the decision to spend time outdoors (Shove, 2008).

Creating thermal comfort with background heating and local supplementary warmth should more often be considered as a heating strategy in churches. Aside from technical upgrades of the building fabrics and services to address thermal comfort, this strategy can easily complement such upgrades and achieve better savings (Humphreys, 2011). Studies of thermal comfort in churches have shown that the operative temperatures that churchgoers consider thermally neutral have varied greatly in different cultures (de Dear, 1998, Humphreys, 1976).

To enable comparison of perceived thermal comfort levels occurring in all four case studies, responses obtained from the thermal comfort questionnaire survey that took place in all churches have been plotted in graphs that have expressed results in percentage of total answers obtained from each case.

Figure 8 reveals that the constantly heated churches (All Saints and Gt St Mary's) with trench LPHW heating system are more likely to offer thermally comfortable environments in comparison to St Botolph's and Queen's College chapel whose answers are distributed towards the cool range of perceived thermal comfort graph. Although in both later churches responses present a rather normal distribution, large percentage of respondents indicated cool and slightly cool feeling, due to lack of constant heat inputs and thus low radiant temperatures expected to occur in these cases.

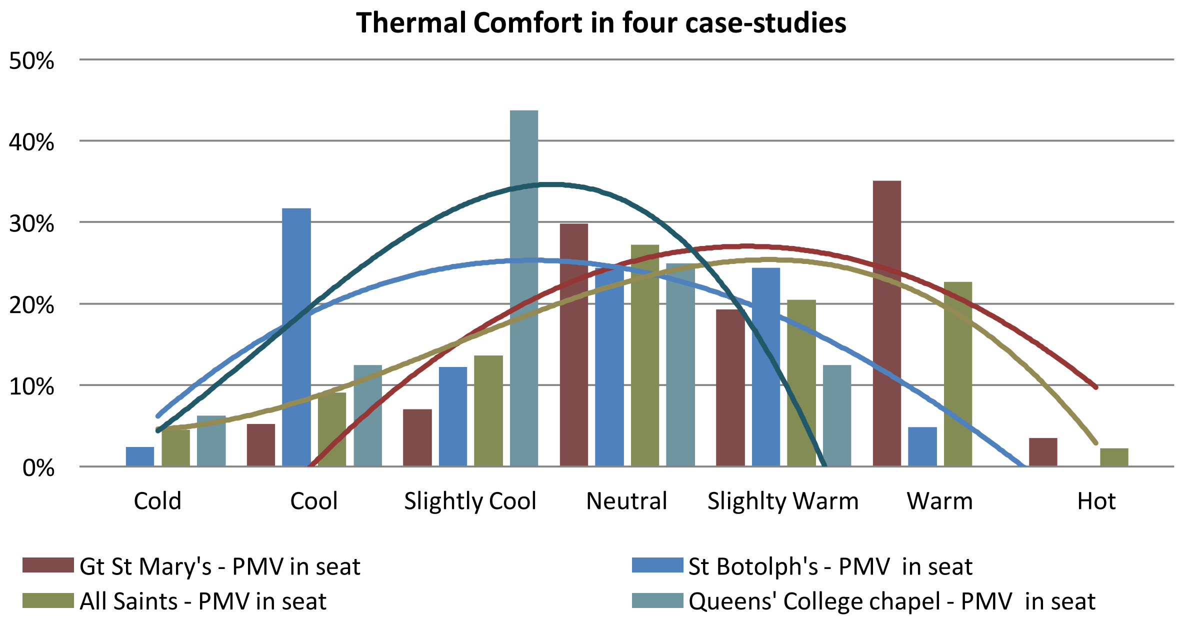

Figure ***Error! No text of specified style in document.*** *Perceived thermal comfort levels inside all four case-studies.*

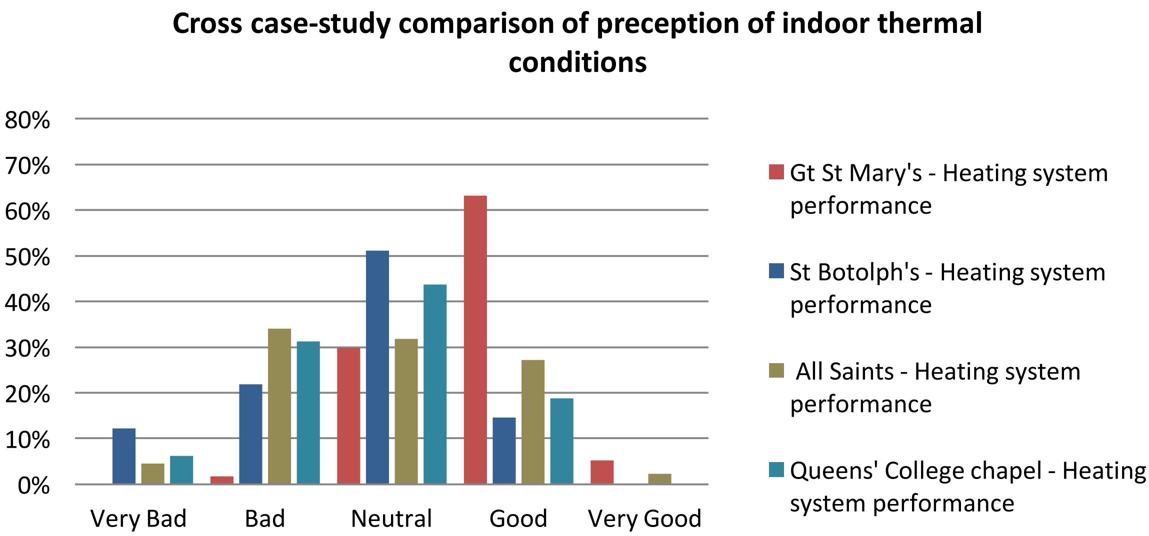

Figure 9 Rating of overall thermal conditions occurring inside all four case-studies as indicated by questionnaire survey respondents.

Conclusions

It is key to improve energy and environmental management of historic buildings with minimal intrusion. As in all other sectors, sustainable development in the historic built environment becomes a necessity. It is imperative for historic structures to reduce their footprint too. However, to achieve this, from an environmental performance point of view, buildings need to satisfy three key elements:

- **Energy Efficiency**

Historic buildings and especially church buildings can often be found on exposed sites; structures are often massive, porous and damp. Due to the heritage value of their fabric and artefacts they contain, there are significant constraints on the type of environmental adaptation measures which can be used to upgrade their efficiency. For example, thermal insulation can be installed in roofs but is very difficult to incorporate in walls without significant effects on the building's appearance. Most improvements focus on renewing or upgrading existing building services, mainly heating systems in historic churches. However, building services are often difficult to select appropriately thanks to limited knowledge of the mechanisms that affect building fabric conservation and occupants' satisfaction; and due to restrictions on budgets to run them.

- **Conservation of Historic Fabric**

To maintain usability and increase interest in historic buildings, in is important to conserve fabric and conserve in vigorous and economical ways. However historic structures, such as church edifices pose more serious difficulties in applying effective and appropriate control of the environment than other building types. Best practice scenarios and principles are essential.

- **Human Factor**

Although general guidance for design criteria for comfort exists, these need to be re-assessed. The research undertaken in four case studies in Cambridge, has proven that existing conditions should be further investigated to take into account human perception as well, rather than simply using predicted comfort models. Very often requirements of people, objects and fabric, appear to be in conflict; however this research suggests that it is possible to combine occupant satisfaction, conservation and energy efficiency.

Nevertheless, it is imperative to achieve better communication among key stakeholders, including practitioners, such as architects, conservators, building services engineers, building managers and curators, in order to achieve effective exchanges of knowledge that can balance the requirements of each party and thus benefit a wider public audience and society. Interdisciplinary thinking can result in better solutions.

Most of the adaptation solutions already exist and do not require of very complicated and technologically advanced equipment. The most important requirement is having a comprehensive insight into the environmental requirements of occupants, historic elements and the energy saving options available. It is often said that the "best is enemy of good", often analysis shows that trying to improve rather than reach some notional ideal may be the best and most practical solution for interventions in the historic built environment.

References

Bird, P. 1959. Churches, Artists, and People. *Studies in Conservation,* 4 (2).

Camuffo, D., Pagan, E., Schellen, H., Limpens-Neilen, D., Koslowski, R. & Bratasz, L. 2007. *Church Heating and the Preservation of the Cultural Heritage. Guide to the Analysis of the Pros and Cons of Various Heating Systems. Results of the European project Friendly Heating (EVK4-CT-2001-00067),* Brussels, European Comission.

Cofe 2008. Shrinking the footprint, The Church of England's National Environmental Campaign, Guidance on Energy Efficient Operation and Replacement of Plant and Equipment. *Deliverable D9 Carbon Management Programme.* London: Church of England.

Curteis, T. 2004. Environmental Conditions in Historic Churches: Examining their effect on wall paintings and polychrome surfaces *Transactions of the Ecclesiastical Architects and Surveyors' Association,* 5 36 - 46.

Curteis, T. 2008. The survey and identification of environmental deterioration. *The Building Conservation Directory.* London: Cathedral Communications Ltd.

De Dear, R. J., & Brager, G.S. 1998. Developing and adaptive model of thermal comfort and preference. . *ASHRAE Transactions,* 104 (1).

Defra 2009. Waste Strategy, Annual Progress Report 2008/09. London: Department for Environment, Food and Rural Affairs.

Diocese of London 2011. Options, Challenges, Solutions, Limitations. *Environmental Challenge.* London: Diocese of London.

Diocese of London And Carbon Trust 2011. Generic Building Solutions. *In:* ARUP (ed.).

Douglas, J. 2002. Building adaptation. Oxford: Butterworth-Heinemann.

English Heritage 2002. Heritage Dividend 2002. Swindon: English Heritage.

English Hertiage 2005. Regeneration and the Historic Environment. Heritage as a catalyst for better social and economic regeneration. London: English Heritage.

Harvey, J. 1972. *Conservation of Buildings,* London John Baker.

Heritage, E. 2008. Energy conservation in traditional buildings. London: English Heritage.

Humphreys, M., Nicol, F., & Roaf, S. 2011. Keeping warm in a cooler house creating thermal comfort with background heating and local supplementary warmth. *Historic Scotland Technical Paper 14.* Scotland: Historic Scotland.

Humphreys, M. A. 1976. Field studies of thermal comfort compared and applied. *Journal Inst. Heaing. & Ventilation. Engineering* 44 5-27.

Jackson, M. 2005. Embodied Energy and Historic Preservation: A Needed Reassessment. *APT Bulletin,* 36 (4): 47-52.

Kelleher, S. (ed.) 2003. *New Work in Historic Places of Worship,* Swindon: English Heritage

Maddex, D. & National Trust for Historic Preservation in the United States 1981. *New energy from old buildings,* Washington, D.C., Preservation Press.

Meryman, H. 2005. Structural Materials in Historic Restoration: Environmental Issues and Greener Strategies. *APT Bulletin,* 36 (4): 31-38.

Pearce, D. 1989. Conservation today. London.

Pickard, R. 2004. The Role of Historic Buildings in Urban Regeneration: Eleventh Report of Session 2003–04. *House of Commons ODPM: Housing, Planning, Local Government and the Regions Committee.* London: The Stationery Office Limited.

Rodwell, D. 2007. *Conservation and Sustainability in Historic Cities,* Oxford, Blackwell publishing Ltd.

Sedovic, W. 2003. History's Green Genes. *The second International conference on Sustainability (GreenBuild), 12-14 November 2003.* Pittsburgh, PA: Green Building Council.

Sedovic, W. & Gotthelf, J. H. 2011. Paradox to Paradigm. Sustainability & Performance of Heritage Buildings. *Proceedings of Energy Management in Cultural Heritage conference, 6-8 April 2011.* Dubrovnik, Croatia.

Shove, E., Chappells, H., Lutzenhiser, L., & Hackett, B. 2008. Comfort in a lower carbon society. *Building Research & Information,* 36 (4): 307-311.

Taylor, J. 2010. Listed Places of Worship. *The Building Conservation Directory.* London: Cathedral Communications Ltd.

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Firm Level Motivations and Barriers for Initiating Sustainability Transitions in the Norwegian Energy System

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1. Contextures of Sustainability Transitions

It is well understood that humankind is set upon an unsustainable trajectory. In attempts to understand how we can begin to make a shift towards a more sustainable path, academics have begun devising several emerging theories of sustainability transitions. The transfer of resources from non-sustainable to sustainable sectors, a process that Cooke (2012) has defined as transversality, is crucial to succeeding the grand energy system transition. This restructuring of societal production and consumption patterns will not occur overnight, and thus transitions are understood to be long-term processes spanning multiple decades (Konrad et al., 2008, Farla et al., 2012). As a point of departure we find it prudent to share Jørgensen's belief that sustainability should be considered as a journey, rather than a destination. What is the role of dominant firms in this journey? Do they take a proactive or reactive stance? What are their motivations for pursuing sustainability? What barriers stand in their way? These questions have been posed before, yet there is much work to be done to complete our understanding.

According to Moors et al. (2004) transitions are regarded as large societal transformation processes which are not deterministic or predetermined, and involve the emergence and diffusion of new technologies into user domains with societal embedding. With the pursuit of sustainability at the focal point, understanding how processes unfold that engage transitions is of importance to scholars and other stakeholders alike. Much focus has been placed upon framing sustainability transitions in a larger systems perspective which has shed light on the bigger picture but according to Farla et al. (2012) these insights may have overshot more actor oriented analyses. In light of much work that has been done in the technological innovations systems and strategic management frameworks, we have begun to understand how niche innovations have the capability to disrupt the existing regime and force prevailing actors to respond to such niche innovations. A prevailing *a priori* assumption in the strategic niche management and technological innovation systems literature is that incumbents resist changes within the regime, are focused upon pursuing their *status quo* through the control of resources, and most importantly, take a reactionary stance towards green innovations that guide the regime towards sustainability transitions (Jacobsson and Lauber, 2006). Whilst there is antecedent evidence to support this claim, we believe one in the same as Bob Dylan in that the 'times are a changin'. Whilst new entrants may at times be credited for the creation of niche green innovations that promote the sustainability agenda, we argue that it is the incumbents who embrace these that realize the rollout from niches to full scale market economies with these innovations.

It has been well versed that disruptions to the regime can come from innovations or landscape forces, but what is overlooked is the transformation from inside the regime itself. We argue that the role of transversality at the incumbent level of the regime is constrained by the firms' dynamic capabilities and motivationally impinged upon their future strategic orientations. The article is structured as follows. First we discuss the role of incumbents in regimes, followed by linking extant grounded theories in strategic management to discourse in sustainability transitions. We follow with presenting the research backdrop and questions for empirical investigation. Section 4 outlines our methodological approach, with ensuing results presented in section 5. We conclude with some theoretical implications for sustainability transitions and propositions for further research.

1.1. Incumbents and the triple P

A key node in sustainability transitions theory is the role of firms. The success of sustainability oriented transition management depends greatly on interactions, performance (Morioka et al., 2006), and intentions of the stakeholders involved. In the case of actors within the energy regime, one of the largest challenges to achieving sustainability transitions is surmounting the path dependence and lock-in conundrum. This entrapment in existing systems may be difficult to dislodge (STRN, 2010), but we must be mindful that transitions unfold over longitudinal time scales and thus it is most interesting to gain more insight into the timing of actor engagements that disrupt, or perhaps intervene upon, existing path dependencies.

It has been commonly argued that niche actors create protected spaces in a technological regime, and incumbents are forced to respond to such new innovations (Hockerts and Wüstenhagen, 2010, Farla et al., 2012). We have thus set forth an empirical analysis of the energy regime in Norway in attempts to uncover several key facets of how sustainability transitions unfold at the regime level. Contrary to Penna and Geels assessment (2012), we posit that a number of incumbent actors proactively engage into the green innovation agenda on their own volition.

1.2. On the need for the inclusion of complementing theories

It has been stated there are many theoretical advancement opportunities in sustainability transitions theory through the inclusion and incorporation other existing and established theoretical knowledge bases (Markard et al., 2012). Amongst these vast opportunities, we have chosen to incorporate doctrines rooted in strategic management studies into our theoretical framework.

One of the key theoretical challenges in sustainability transitions is the appropriate construct of its conceptualization when so many factors are at play. Jørgensen (2012) proclaimed one and the same highlighting the need 'to combine an analytical understanding of… path dependent dynamics of dominant societal configurations…with a process oriented understanding of situated actor's possibilities of engaging in transitional processes.' This vulnerability creates opportunities for sustainability transitions to come under stark criticism from distinct academic disciplines. Ranging from policy to society to industry regimes which all take a stake and play a role in transitions, proponents of the multilevel perspective have worked feverishly to address this theoretical demurring (Geels, 2011, Smith et al., 2010). In line with Markard et al. (2012), we believe that sustainability transitions can benefit greatly from the inclusion of existing theories that can ultimately both critique and broaden existing theoretical knowledge of the field.

2. Theories On Strategic Orientations of the Firm

Strategic orientation is a concept widely used in the research field of strategic management to reflect future directions of the firm as devised in a strategic corporate plan. It involves the conceptualization of how a firm will position itself moving forward with the creation of a plan, and the managerial actions to allocate of resources to implement that plan. Strategic orientations may entail a variety of options for the firm including internationalization, diversification, and innovation activities. The underlying rational for incorporating the following theoretical contributions from management science and their connection to the role that incumbents play in sustainability transitions is the simple question: how do firms explore to create new value?

2.1. Market and Product Mixes

According to industry life cycle theory firms must seek new ways to create value to survive the long haul. A firm eventually finds itself seeking to take existing products or services into new markets or develop new ones for their existing market. This has traditionally been conceived to occur at the maturity or decline stages of the model. Firms therefore either look for new ways of consolidating or increasing their domestic market shares (Gallego et al., 2009) through incremental product and service innovations, or seek market expansion abroad. Managerial perceptions of stimuli, their attitudes towards risk, and an understanding of the firms resource base create the foundation for which strategic orientation decisions of the firm are made. Firm level positing and their resource base within a given industry will play a major role in their capability to engage into new activities. Scholars have thoroughly investigated the identification and significance of firm resources with attention being paid to tacit knowledge, network capabilities, financial wherewithal, and innovative capabilities.

The focus of our work is then upon diversification in strategic reorientation. Diversification in strategic management has taken a wide form of constructs over its theoretical evolution, but we choose to focus on product and market level diversification based upon Ansoff's seminal work (1957) reflected in Figure 1. It is well established that diversification basically occurs along the two axes of market and technology, and often in 'proximity' to skills/technological relatedness to the 'base position' of a given firm (Neffke and Henning, 2012). Theory suggests that a key element in firms' diversification strategies is to leverage existing resources by slowly shifting product and market penetration matrixes further out along both axes.

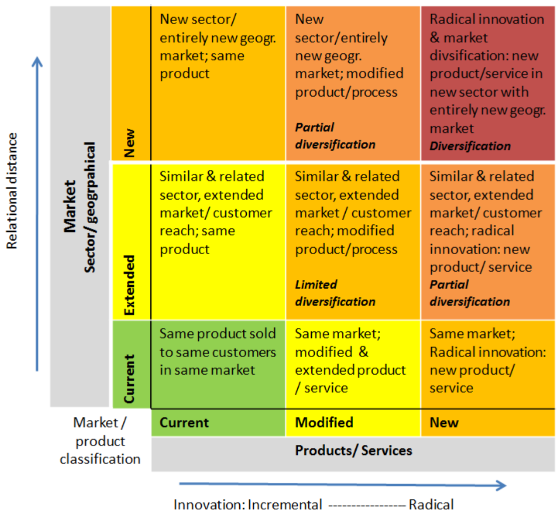


Figure 1. Product and market diversification mix; modified from (Ansoff, 1957)

2.2. The corporation as an entrepreneur?

The recent academic definition of entrepreneurship goes far beyond its historical connotation of small startups. Entrepreneurship embodies risk taking, proactivity, innovativeness, and strategic response to a recognized need through coordinated economic activity. Given that corporations are nothing more than a collection of individuals, they possess the same capability to demonstrate these characteristics as a single individual. Therefore the notion of entrepreneurship has been extended beyond its neoclassical meaning to include all collections of individuals that exhibit such behavior, including corporations. These newly defined boundaries have given rise to the growing body of literature on corporate entrepreneurship. It reflects how established corporations can act entrepreneurially by venturing into new business areas to identify and explore the potential of new business opportunities, even at times when no existing market for the product exists (Frederiksen and Davies, 2008). Thus firms that engage in diversification by extending their activities into areas marginally related to their current domains of competence exhibit characteristics of corporate entrepreneurship (Burgelman, 1983).

Corporate environmental strategies began to take shape in accordance with greater demand for corporate social responsibility throughout the 1990s, resulting in a strand of entrepreneurship literature based around these principles. Sustainability transitions and sustainable entrepreneurship share close linkages. According to Hockerts and Wüstenhagen (2010), sustainable entrepreneurship is the 'discovery and exploitation of economic opportunities…that initiate the transformation of a sector towards an environmentally and socially more sustainable state' (p.482). An alliance that the sustainable entrepreneurship research stream shares with sustainability transitions is the notion that new entrants disrupt stability in the regime, forcing incumbent firms to respond to new green niche innovations. Hockerts and Wüstenhagen's conceptual work offered us a significant takeaway: when incumbents positively respond to market introductions from new entrants, incumbents propel transitions. They deem incumbents engaged in these gradual transformations 'greening goliaths,' as strategic reorientation repositions incumbents along new lines towards sustainability paths.

2.3. To Track on Beaten Paths or Forge New?

The concept of organizational learning through exploration versus exploitation was championed by March (1991) which implied that firms choose between two trajectories to renew knowledge based assets of the firm. Exploitation emphasizes refining the firms knowledge base through incremental steps with high degrees of control, certainty and risk minimization (Prange and Verdier, 2011), whereas exploration entails greater departure from the norm implying more risk of expansionary plans outside of core competencies (March, 1991, Barkema and Drogendijk, 2007) with discovery, experimentation, and innovation at its core (Prange and Verdier, 2011). According to (He and Wong, 2004, Benner and Tushman, 2003, Barkema and Drogendijk, 2007), firms operating in a technological domain seeking exploitation improve on existing components within existing product and market domains, whereas exploration implies a shift to a different technological trajectory altogether.

2.4. Path Dependence and Lock In

As firms move further through industry life cycle their past histories may constrain what they can do in the future (Teece et al., 1997). These path dependencies give a firm their current stock of capabilities but also constrains future strategic options (Medcof, 2000). Path dependence is a powerful force in energy systems (Lovio et al., 2011) as much of the existing system is characterized by stability, lock-in (Verbong and Geels, 2010) and large sunk costs into the existing infrastructure. Outside of the obvious infrastructural lock-in that embodies energy systems, the related skills and belief systems associated with former legacies complicate transitions towards new systems (Verbong and Geels, 2010) or paths breaking away from the sector all together. This entrapment in existing systems may be difficult to dislodge (STRN, 2010), but it is most interesting to gain more insight into the timing of actor engagements that disrupt, or perhaps intervene upon, existing path dependencies.

The past may not only constrain and shape on-going evolution, but also constitutes the platform for which diversification processes unfold, implicating an enabling view on path dependence (Martin and Sunley, 2006). In line with Dewald and Truffer (2012) we argue that cross-sectorial resource transfer will depend on firms' historic capabilities and will be impinged upon their strategic intentions to pursue new product and market opportunities.

3. Motivation for this Contribution

We find it timely to research diversification and path creation within the energy system due to the fact many energy systems throughout the world are undergoing transformation along political, technical, and socio-economic lines. Therefor the underlying tenant to this research stream is the need to understand processes that firms in a given regime endure, and more specifically for our work, the effects of being exposed to new stimuli that act as triggering factors which forces firms to search for new paths in either proactive or reactionary stances.

3.1. Research Setting

Norway is an energy nation. As a country it is a major global producer and exporter of natural gas and oil (gas: 4th, 3rd; oil: 15th, 7th respectively). The extraction of fossil fuels on the Norwegian continental shelf currently generate tax revenues amounting to 23% of GDP, and represent about half of total exports, making the petroleum sector Norway's largest industry (OED, 2013). Figure 2 reflects the Norway's drastic increase and imminent decline of petroleum extraction. Like many other countries globally, available reserves are on the decline as peak oil and peak gas have already occurred in the early 2000's (based upon known reserves).

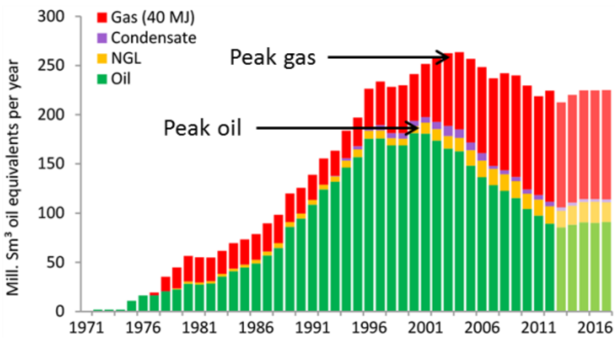


Figure 2 Norwegian peak oil and gas (OED, 2013)

The country has amongst the highest percentage of renewable energy in its electricity supply globally (over 97%), provided namely through hydropower that was primarily built out during the water wave of the 50s-80s. The global rise of environmental and social concerns that plagued the hydropower industry throughout the 1990s and 2000s drastically slowed down new development of this clean energy resource. Of Norway's total domestic hydropower resource base of 217 TWh, 60% has been built out, 25% is protected, leaving 15% available for further development for future generations to meet future energy needs (NVE, 2011).

With the EU renewable energy directive, Norway has also committed to increasing its share of primary renewable energy consumption from the 2005 baseline year of 60,1% to 67,5% in 2020. The strategic plan of implementation has resulted in a joint subsidy support mechanism for renewable energy in the power sector with Sweden, with both countries jointly responsible for adding 26,4 TWh of new clean power to the common grid. Interestingly enough, the estimated production trajectory of renewable energy share of electricity for Norway was cited at 113,6% in 2020, reflecting large renewable energy export plans with the surplus (MPE, 2012).

Given this background context of a nation that has built strong industrial foundations around these two core industries in which limited opportunities existed for both more fossil extraction and hydropower development in the mid to late 2000's, we find it most interesting and timely to empirically investigate if and how sustainability transitions are unfolding. What will the Norwegian energy system transformation look like? Will the oil and gas sector strategically reorient itself from grey to green? Given the favorable existing high penetration of renewables in the power sector, what technologies will be utilized in expanding production?

3.2. Research Question

In light of the aforementioned literature review, we propose the following research question:

What are firm level motivations and barriers for pursuing diversification within the energy regime?

That transitions unfold over long time scales, we find it prudent to investigate why firms are interested in pursuing the 'green agenda,' and equally importantly, what barriers stand in the way of doing so. Understanding that motivations and barriers come from both inside the regime and the external landscape, we developed two frameworks that reflect both internal and external motivations and barriers as depicted in Figures 3 and 4. Furthermore we developed our framework to test whether firms in the energy system are more proactive or reactive, based upon their motivations for engaging into new activities that promote sustainability transitions.

	Proactive	Reactive
Endogenous	-HR strategy (attract / hold talent) -Reuse competence and resources in new area	-Reduce dependence on main activity -Low returns on main activity
Exogenous	-More attractive business opportunities -Positioning for future	-Stagnation in main activity (sector) -Following customers /competition

Figure 3. Motivational framework for pursuing diversification within the energy system

Endogenous	-Lack of internal knowledge resources -Access to competent talent -Lack of financial capacity
Exogenous	-Unclear politics -Uncertain subsidies-tax mechanisms -Access to new resource areas

Figure 4. Barriers framework for pursuing diversification within the energy system

4. Methodological Structure

Our research design for answering the aforementioned research questions consisted of an industry wide web based survey throughout the energy sector in Norway. Our strategic sample and respondent list was collected and compiled through industry representative organizations, consisting of 783 firms in total. We grouped our respondents into three primary classifications as reflected in Figure 5: energy producers, product suppliers, and service suppliers. Our belief is that incumbents within these classifications play different roles in the shaping of the industry, and our goal was to capture these regime dynamics.

In line with Cooke's (2011) notion of transversality, our methodological approach to track diversification has been tailored to fit the sustainability transitions framework as we sought to underpin transfer of resources between non-sustainable sectors (oil and gas) to sustainable ones (renewable energies). Diversification options were thus limited to renewable energies, as opposed to a variety of industries outside the energy sector for which we could not make the clear argument and distinction of resource transfer leading to sustainability transitions.

4.1. Research Model

Figure 5 reflects our methodological approach in a research model. We sought to capture a current picture of incumbents' current situation, i.e. what their business dynamic is. This involved a number of descriptive elements about their firm and current activities, in addition to managerial perceptions about former and future market developments. This structure sought to underpin product and market level diversification as laid forth in Figure 1.

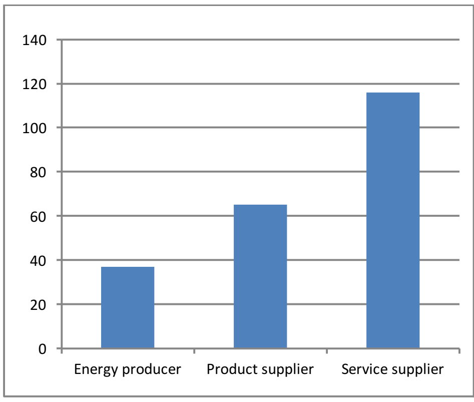
Figure 5. Research model for strategic reorientation in transversality

4.2. Measures and Analysis

Key measures utilized a seven point Likerts scale, indicating degrees of assessment with the variables presented. Survey results are presented as descriptive statistics below.

5. Results

The survey produced 220 responses, a response rate of 28%. Individuals with senior leadership roles make up 55% of total respondents. Figure 6 shows the industry composition of each according to the firms' stated primary activity. Figure 7 breaks down the activities of the incumbents in both regimes.



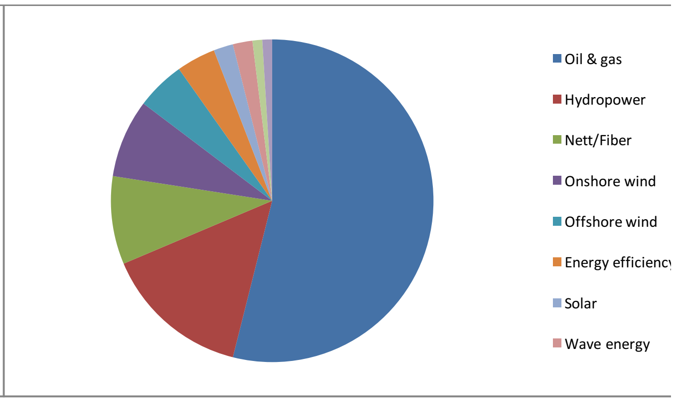


Figure 6. Activities of the respondents *Figure 7. Composition of the respondents' main sectors*

Following our framework in Figure 3, motivational results for pursuing transversality within the energy system are presented in Figure 8.

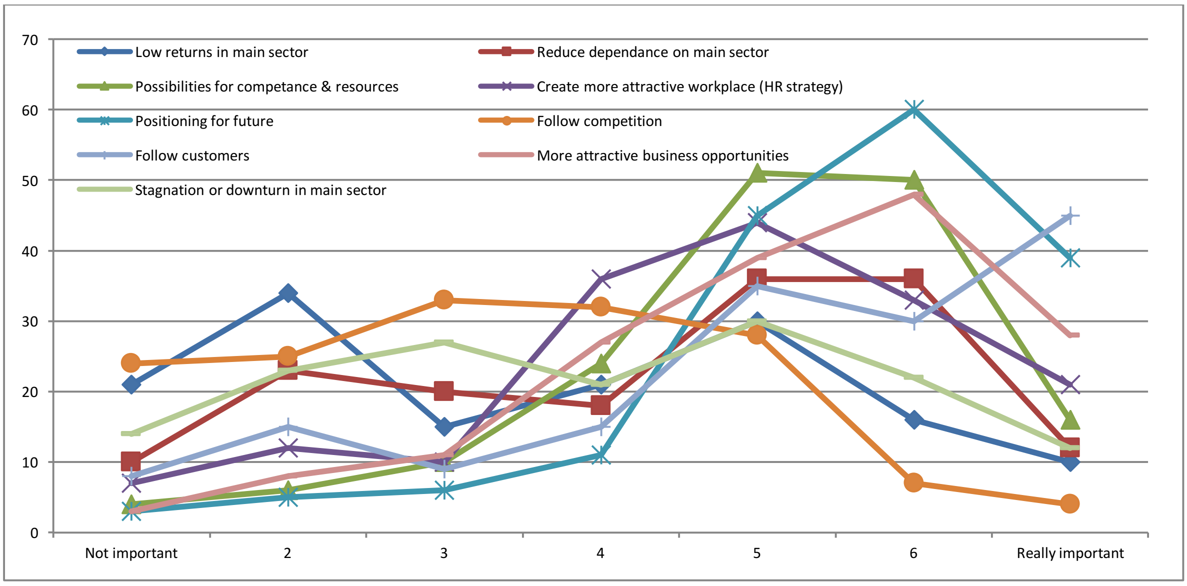


Figure 8. Motivations for pursuing sustainability transitions

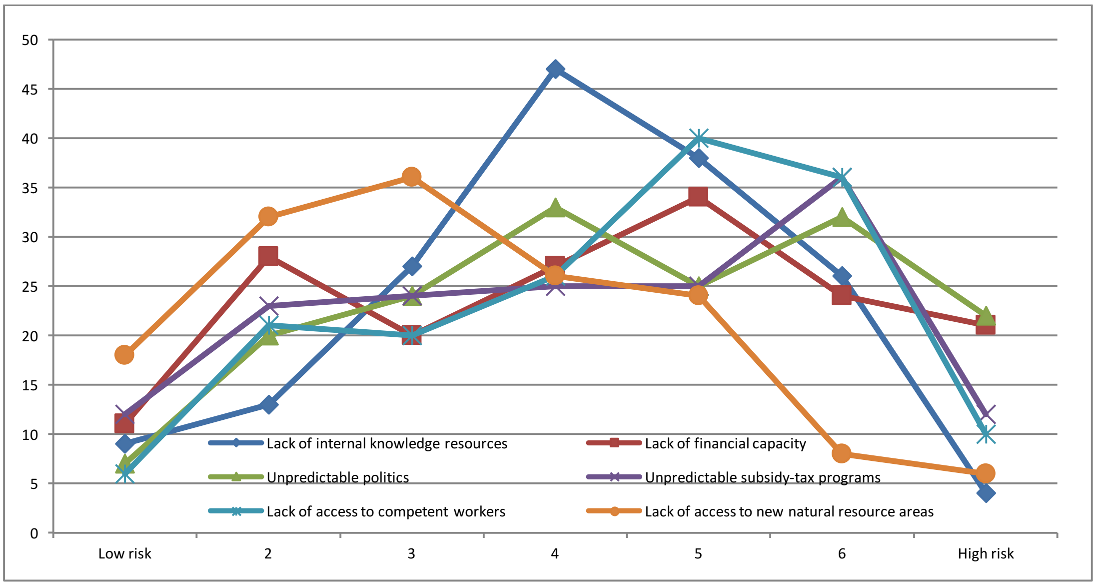


Figure 9. Barriers to pursuing sustainability transitions

6. Theoretical Implications for Sustainability Transitions

Industry plays a critical role in sustainability transitions as the link between technology and society (Morioka et al., 2006). In addressing the compound problems of lock-in and path dependence within (energy) regimes, it is well understood that 'uncertainties about future market and regulations hinder the commitment of firms to the development (or implementation) of sustainable technologies…because of market uncertainties and fear of cannibalising their existing products' (Geels et al., 2008). This antecedent conclusion offers us several takeaways when analysing incumbents within their prospective regimes. First, a strong market demand for new green innovations must exist for incumbents to pursue them. Second, the policy and regulation of their existing business line and the technological maturity of the new innovation being pursued must align in a way that allows firms to envisage a promising economic future in the new green innovation while simultaneously supressing the outlook for their existing (unsustainable) business activity. Thus regulation plays a key role in advancing transitions by creating frameworks that offer a roadmap towards sustainability, and thus a way to begin the transition out of path dependency and lock-in of existing systems. Given that all firms pursuing multiple paths face internal competition for resources, the allocation of such resources between new and old activities characterizes the managerial challenge of pursing sustainability transitions.

References

Ansoff, H. I. 1957. Strategies for diversification. *Harvard Business Review,* 35, 113-124.

Barkema, H. G. & Drogendijk, R. 2007. Internationalising in small, incremental or larger steps? *Journal of International Business Studies,* 38, 1132-1148.

Benner, M. J. & Tushman, M. L. 2003. Exploitation, exploration, and process management: The productivity dilemma revisited. *The Academy of Management Review*, 238-256.

Burgelman, R. A. 1983. Corporate entrepreneurship and strategic management: Insights from a process study. *Management science,* 29, 1349-1364.

Cooke, P. 2011. Transversality and regional innovation platforms. *In:* COOKE, P., ASHEIM, B. T., BOSCHMA, R., MARTIN, R., SCHWARTZ, D. & TÖDTLING, F. (eds.) *Handbook of Regional Innovation and Growth.* Cheltenham: Edward Elgar.

Cooke, P. 2012. Transversality and Transition: Green Innovation and New Regional Path Creation. *European Planning Studies,* 20, 817-834.

Dewald, U. & Truffer, B. 2012. The Local Sources of Market Formation: Explaining Regional Growth Differentials in German Photovoltaic Markets. *European Planning Studies,* 20, 397-420.

Farla, J., Markard, J., Raven, R. & Coenen, L. 2012. Sustainability transitions in the making: A closer look at actors, strategies and resources. *Technological Forecasting and Social Change,* 79, 991-998.

Frederiksen, L. & Davies, A. 2008. Vanguards and ventures: Projects as vehicles for corporate entrepreneurship. *International Journal of Project Management,* 26, 487-496.

Gallego, M. Á., Hidalgo, E. R., Acedo, F. J., Casillas, J. C. & Moreno, A. M. 2009. The relationship between timing of entry into a foreign market, entry mode decision and market selection. *Time & Society,* 18, 306-331.

Geels, F. W. 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions,* 1, 24-40.

Geels, F. W., Hekkert, M. P. & Jacobsson, S. 2008. The dynamics of sustainable innovation journeys. *Technology Analysis & Strategic Management,* 20, 521-536.

He, Z.-L. & Wong, P.-K. 2004. Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. *Organization science,* 15, 481-494.

Hockerts, K. & Wüstenhagen, R. 2010. Greening Goliaths versus emerging Davids — Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. *Journal of Business Venturing,* 25, 481-492.

Jacobsson, S. & Lauber, V. 2006. The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. *Energy Policy,* 34, 256-276.

Jørgensen, U. 2012. Mapping and navigating transitions—The multi-level perspective compared with arenas of development. *Research Policy,* 41, 996-1010.

Konrad, K., Truffer, B. & Voß, J.-P. 2008. Multi-regime dynamics in the analysis of sectoral transformation potentials: evidence from German utility sectors. *Journal of Cleaner Production,* 16, 1190-1202.

Lovio, R., Mickwitz, P. & Heiskanen, E. 2011. Path dependence, path creation and creative destruction in the evolution of energy systems. *In:* Wüstenhagen, R. & Wuebker, R. (eds.) *Handbook of Research on Energy Entrepreneurship.* Cheltenham: Edward Elgar.

March, J. G. 1991. Exploration and exploitation in organizational learning. *Organization science,* 2, 71-87.

Markard, J., Raven, R. & Truffer, B. 2012. Sustainability transitions: An emerging field of research and its prospects. *Research Policy,* 41, 955-967.

Martin, R. & Sunley, P. 2006. Path dependence and regional economic evolution. *Journal of Economic Geography,* 6, 395-437.

Medcof, J. W. 2000. The resource-based view and transnational technology strategy. *The Journal of High Technology Management Research,* 11, 59-74.

Moors, E., Rip, A. & Wiskerke, J. S. 2004. The dynamics of innovation: a multilevel co-evolutionary perspective. *Seeds of Transition: essays on novelty production, niches and regimes in agriculture. Assen: Van Gorcum*, 31-56.

Morioka, T., Saito, O. & Yabar, H. 2006. The pathway to a sustainable industrial society–initiative of the Research Institute for Sustainability Science (RISS) at Osaka University. *Sustainability Science,* 1, 65-82.

MPE 2012. National Renewable Energy Action Plan under Directive 2009/28/EC. Norwegian Ministry of Petroleum and Energy.

Neffke, F. & Henning, M. 2012. Skill relatedness and firm diversification. *Strategic Management Journal*, n/a-n/a.

NVE 2011. Energy Status Norwegian Water and Energy Directorate.

OED 2013. Facts 2013. Norwegian Petroleum Directorate.

Penna, C. C. R. & Geels, F. W. 2012. Multi-dimensional struggles in the greening of industry: A dialectic issue lifecycle model and case study. *Technological Forecasting and Social Change,* 79, 999-1020.

Prange, C. & Verdier, S. 2011. Dynamic capabilities, internationalization processes and performance. *Journal of World Business,* 46, 126-133.

Smith, A., Voß, J.-P. & Grin, J. 2010. Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research Policy,* 39, 435-448.

STRN 2010. A mission statement and research agenda for the Sustainability Transitions Research Network.

Teece, D. J., Pisano, G. & Shuen, A. 1997. Dynamic Capabilities and Strategic Management. *Strategic Management Journal,* 18, 509-533.

Verbong, G. P. J. & Geels, F. W. 2010. Exploring sustainability transitions in the electricity sector with socio-technical pathways. *Technological Forecasting and Social Change,* 77, 1214-1221.

Opening image credit: Smøla Wind Farm, Smøla Island – the largest wind farm in Norway, with 68 turbines. Flickr Creative Commons/Statkraft

Waste Management and Pollution Control in the Lake Malawi Basin:
Harnessing Synergies from Various Sectors for Sustainable Lake Basin Management

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Abstract

Lake Malawi hosts the greatest freshwater fish biodiversity in the world, and is world's third deepest and ninth largest lake by surface area. The lake and its basin offer a wide variety of values to the Malawi population including supporting urban centers, rain-fed and irrigated agriculture, hydropower generation, mineral resources provision, and abundant fisheries resources. Associated activities result in the generation of wastes and pollutants that also impact on the lake basin. Management of waste is a big challenge in Malawi, in addition to deforestation and the associated soil erosion. This paper assesses the waste management and pollution control situation in the Lake Malawi Basin from a governance perspective, as a rough indication of the management status of water resources in Malawi. The focus is on understanding how synergies from various related sectors such as agriculture, sanitation, forestry, mining, industry and others can be harnessed for better lake basin management. The study also assesses the degree of point source pollution control, and solid waste management in the major cities within the lake basin. The methods employed are documents review, key informant interviews and site observations. Results show weak enforcement of regulations and standards, poor solid waste management especially due to challenges in collection and final disposal facilities, and while there are some efforts with respect to non-point source pollution, deforestation and soil erosion remain a problem.

Keywords: Lake Malawi Basin, pollution control, waste management, water resources management, sustainability

1. Introduction

Lake Malawi hosts the greatest freshwater fish biodiversity in the world, and is world's third deepest and ninth largest lake by surface area (Bootsma & Hecky, 1999, 2003). The lake and its basin are shared among Malawi, Mozambique and Tanzania with the largest portions of both the basin and lake in Malawi. This paper focuses on the lake and basin in the Malawi side. The lake and its basin offer a wide variety of benefits to the Malawi population including supporting urban centres, rain-fed and irrigated agriculture, hydropower generation, mineral resources provision, and abundant fisheries resources. The lake is Malawi's most dominant water body and stores the bulk of the renewable surface water resources in the country, with an average of 90km^3 of live storage (GoM 2008). Its importance therefore cannot be ignored especially with the fact that Malawi is a water stressed country with total renewable water resources per person of less than 1,400m^3/year (GoM, 2008). In addition, water is central to poverty alleviation (Pérez-Foguet & Garriga, 2011), and in Malawi in particular, water resources are an important driver of the economy. For instance, Lake Malawi supports hydropower generation on its only outlet, the Shire River which generates about 95% of all electricity in the country (Chafota, Burgess, & Johnson, 2005).

Activities associated with the benefits the lake and its basin offer however, result in the generation of wastes and pollutants that also impact on the lake and basin. If not properly managed, these wastes and pollutants can lead to the degradation of the lake basin with negative consequences on the country's economy and the people's well-being. The Malawian side of the basin is largely rural and agriculture is the main land-use activity. The basin contains two major urban centres, Lilongwe the capital of Malawi and Mzuzu, the country's third major city. These cities have the highest population densities in the basin and it is assumed that they also generate the most waste. Generally, management of both solid and liquid waste is a big challenge in Malawi, in addition to deforestation and its associated soil erosion. Management of both solid and liquid waste is currently the responsibility of city councils but there are plans to transfer the management of wastewater to water utilities. Within the Lake Malawi Basin, wastewater treatment works are done in Lilongwe and Mzuzu Cities. The dominant existing treatment types only removes 30% of the organic wastes and 50% of bacteria and suspended solids (Msilimba & Wanda, 2012). This causes concern of nutrient and pollutant loading to water bodies and public health risk. Although the country has national effluent standards in place (for both domestic and industrial wastewater), their enforcement is generally poor. Solid waste management services within the lake basin are also mainly provided in the cities of Lilongwe and Mzuzu. Table 1, provides information on land area, population and waste generation rates of the two major cities. The city councils are only able to collect and dispose of a small fraction of the generated waste.

Table1 City Information

City	Land Area*	Population*	Population Density*	Daily Waste Generation** (tons)
Lilongwe	456 Km^2	674,400	1,479/Km^2	350
Mzuzu	48 Km^2	133,900	2,791/Km^2	67

*Land area and population data from 2011 National Statistical Yearbook
**Waste generation rates provided by the city councils

2. Why Waste Management and Pollution Control?

Waste, both solid and liquid has an impact on water resources (Yamada & Muhandiki, 2007; Falkenmark, Anderson, Castensson & Sundblad, 1999). This impact is mainly on nutrient load, pollution risk and suspended solids. High nutrient loads to water bodies interfere with the biochemical structure of the water bodies and leads to eutrophication. This may cause excess growth of alga, shifts in species composition, changes in the food web, limitations to light penetration and public health concerns, among others. Previous studies by other researchers in Lake Malawi identified the main issues as; (1) Water level fluctuations; (2) Changes in phytoplankton composition; (3) Threat to biodiversity; (4) Contamination; (5) Threat to fishery; and (6) Pathogens. Figure 1, shows causal chains of these main issues (except fishery), considering only the main linkages.

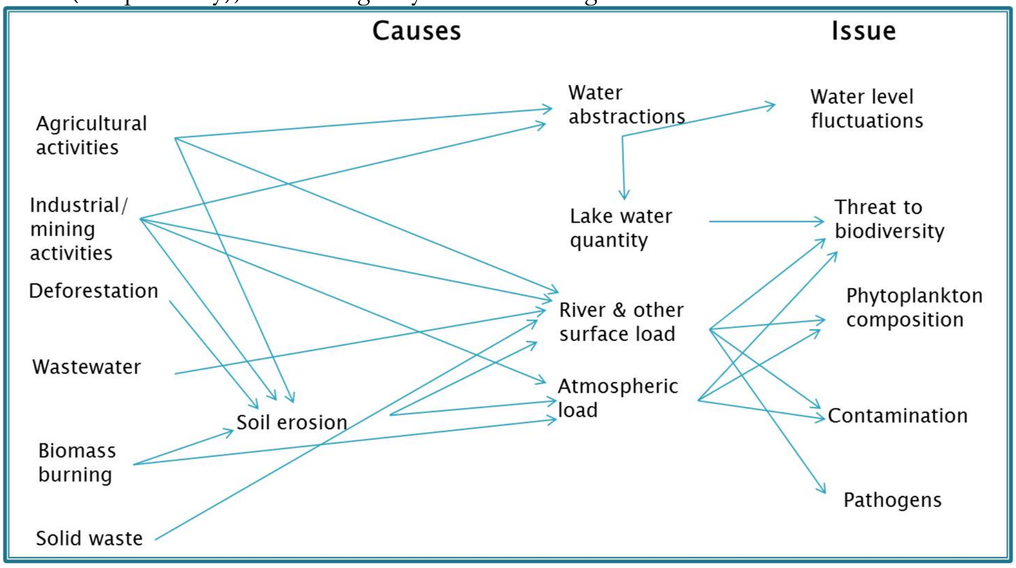


Figure 1. Causal Chains of the main issues in Lake Malawi

The root causes of these issues as shown in Figure 1 are agricultural activities, industrial/mining activities, deforestation, wastewater, biomass burning and solid waste. We did not show fishery in this figure because it is linked with most of the issues and thus its root causes are similar to the root causes of the other issues. These six root causes are our main areas of concern and they are all in some way related with waste and pollution issues. This is the reason our paper is focusing on waste management and pollution control in the lake basin. We grouped the main areas of concern into two main categories of drivers of point source pollution and drivers of nonpoint source pollution as shown in Table 2 below.

Table 2 Main Areas of Concern

Drivers of Nonpoint Source Pollution	Drivers of Point Source Pollution
Deforestation	Wastewater
Agricultural activities	Industrial activities
Biomass burning	
Solid waste	

A closer look at the drivers of nonpoint source pollution category however, shows that all areas except solid waste are closely related with the agriculture and forestry sectors. Consequently, we have isolated solid waste into its own category for better assessment.

In view of the issues highlighted, this paper assesses the waste management and pollution control situation in the Lake Malawi Basin from a governance perspective, as a rough indication of the management status of water resources in Malawi. Our main objectives are to assess;

1. The degree of point source pollution control in the lake basin.
2. The degree of non-point source pollution control in the lake basin.
3. Solid waste management in the major cities within the lake basin.

Our overall objective is to understand how synergies from various related sectors such as agriculture, sanitation, forestry, mining, industry and others can be harnessed for better lake basin management.

3. Methodology

In addition to reviewing several documents and publications, we conducted key informant interviews in various institutions to understand how various mandated institutions are implementing the national policies that govern utilization and management of the various aspects of the lake basin. These were the Departments of Water Resources, Environmental Affairs, Irrigation, Land Resources Conservation and Development (agriculture), Fisheries, Forestry, Energy and the City Councils of Lilongwe and Mzuzu in April and May 2014. We also carried out site observations in the same period. Our assessment utilized indicators which we selected based on the main areas of concern highlighted in previous sections and guided by literature review. The indicators are directly linked to the objectives of this paper and each indicator has several measures or sub-indicators. Table 2 presents the indicators and measures that we used.

Indicator	Measures
1. Degree of Point Source Pollution Control	1.1 Percentage of Households in Lilongwe & Mzuzu Cities connected to the public sewer line 1.2 Sewage effluent standards compliance rate of sewerage treatment plants 1.3 Wastewater sludge disposal compliance rate in cities and towns 1.4 Compliance of industries & mines with standards
2. Degree of nonpoint source pollution control	2.1 Proportion of land covered by forests 2.2 Reduction in hectares destroyed by bush fires 2.3 Farm area under good farming practices 2.4 Protection of catchment & littoral wetlands (swamps & marshes) & lagoons
3. Extent of solid waste management in the cities of Lilongwe & Mzuzu	3.1 Waste collection rate 3.2 Industrial solid waste disposal compliance 3.3 Sanitary condition of final disposal facilities 3.4 Percentage of solid waste recycled

Table 2 Indicators and Measures

The indicators presented in Table 2 represent all the areas considered important in this study. However, due to data limitations that we encountered, we couldn't assess measures 1.2, 1.3, 1.4, 2.2 and 3.4.

4. Findings

Before we present our findings, we would like to explain the rating system we have applied to the indicators. We used a scale of 1 to 5 for every indicator, where 1 is very low and 5 is very high as shown in Table 3 below. Finally, we averaged the individual indicator rates to obtain an overall rate for waste management and pollution control in the lake basin.

Table 3 Rating Scale

Rate	Translation
1	Very Low (≤ 20%)
2	Low (21- 40%)
3	Moderate (41 – 60%)
4	High (61-80%)
5	Very High (≥ 81%)

The following subsections provide the findings.

4.1 Degree of Point Source Pollution Control

Percentage of households connected to the public sewerage system was the only measure assessed under this objective, as indicated in the previous section. Table 4 provides the rate of this indicator.

According to the Lilongwe City Council (LCC) only 9% of the households in the city are connected to the public sewerage system. The majority rely on pit latrines (75%) and septic tanks (UN-HABITAT 2011). When the septic tanks are full, the waste is pumped out and discharged at the sewerage treatment plant. Wastewater sludge from the treatment plants is collected by local residents for use as manure or fertilizer. Challenges LCC is facing in relation to wastewater management include low staffing levels, insufficient facilities, vandalism and theft of infrastructure.

There is no public sewerage system in the City of Mzuzu and residents rely on pit latrines and septic tanks. Mzuzu City Council (MCC) is lacking machinery and technical capacity for proper sewage treatment.

Table 4 Rating for Degree of Point Source Pollution Control

Measure	Lilongwe	Mzuzu	Rate
1.1 Public sewerage connection	9%	0	1
Indicator Rate			**1 (very low)**

While noting the significant data limitations we faced in assessing this objective, our findings show that the control of point source pollution in the lake basin is very weak.

4.2 Degree of Nonpoint Source Pollution Control

In this measure, we adopted the national level forest cover. Malawi's target for forest cover in the Millennium Development Goals (MDGs) is 50% of land area. Forests and woodlands are estimated to cover about 34% of the total land area (FAO, 2010). This estimate is considered outdated and the 2010 State of Environment and Outlook Report for Malawi suggests that the current extent of forest cover is likely much lower. However, due to the absence of a more recent estimate, this paper adopts the FAO 2010 estimate. This is 68% of the MDGs target and is given a high rating according to our criteria. In addition, reforestation activities as well as forest and tree protection efforts have been increasing in recent years. Households and communities have also been encouraged to grow their own trees to meet household demands for cooking energy and construction materials, among others. Community forest areas and regenerated forests were evident in some places during our site observation. That being said however, many other places are still undergoing rapid deforestation.

Malawi classifies 30% of its land as arable. The Department of Land Resources Conservation and Development estimates that about 50% of the country's land is under cultivation, including marginal areas such as river banks and steep slopes. Of the arable land, the Department estimates that 30-40% is currently under good agricultural practices (i.e. minimal disturbance of soil, retention of crop residues and weeds on the soil surface, crop rotation etc).

Protection of lagoons and wetlands (swamps and marhes) in the lake basin is partial. Those that are currently under protection are the ones within national parks and wild life reserves e.g. wetlands within Nyika National Park, Vwaza Marsh Game Reserve, Kasungu National Park and Nkhotakota Wildlife Reserve. The lake's littoral wetlands are not protected. Most wetlands in the basin have been modified by anthropogenic activities (GoM 2010). We rated this measure moderate because national parks and wildlife reserves cover a considerable area of the lake basin. Table 5 presents the ratings for each of the measures and the indicator. Overall, the findings show moderate control of nonpoint source pollution.

Table 5 Rating for Degree of Nonpoint Source Pollution Control

Measure	Data	Rate
2.1 Proportion of land covered by forests	34% (FAO, 2010) – national level	4
2.3 Farm area under good agricultural practices	30-40% of Arable land	2
2.4 Protection of lagoons & wetlands (swamps & marshes)	Some protected (Under national parks & wildlife reserves)	3
Overall Indicator Rate		**3 (moderate)**

4.3 Extent of solid waste management in the cities of Lilongwe and Mzuzu

According to LCC, Lilongwe generates about 350 tons of solid waste every day. Mzuzu generates about 67 tons every day, estimated based on Population. Figure 2 provides an indication of the categories and proportions of the solid waste generated in Mzuzu City.

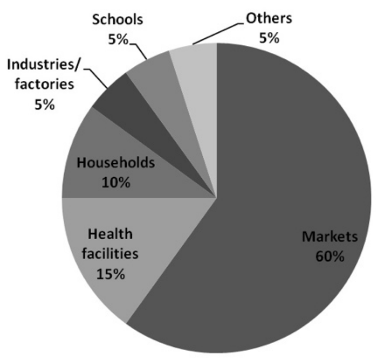


Figure 2. Waste Generation Categories in Mzuzu City (based on data provided by MCC)

As can be seen in Figure 2, most of the waste is generated by markets, health facilities and households. Information on actual waste composition is currently unavailable but generally the majority of the waste is organic. Both cities are only able to collect 30% of the waste generated. Challenges include insufficient waste management machinery, and low stakeholder awareness and participation.

Both cities are practicing open dumping and all waste is finally disposed of at the cities' dumpsites. Industrial waste is disposed of in the same way. Although industries/factories generate less waste compared to the other categories as Figure 2 indicates (assuming the situation in Lilongwe is similar), the indiscriminate disposal of waste calls for concern as some of the industrial waste maybe hazardous. The measure for industrial solid waste compliance is rated very low.

As both cities are practicing open dumping and not much control is exercised, the sanitary condition of the final disposal facilities leaves a lot to be desired. Key informants at the city councils described the condition as appalling, deplorable and pathetic. Figure 3 shows the situation when we visited the sites. Some waste is dumped along the roads to the sites and because of that, we could not access the Mzuzu City dumpsite because the road was blocked with waste.

Figure 3. Lilongwe City Dumpsite (above), and Mzuzu City Dumpsite (below)

Our assessment of the sanitary condition of final disposal facilities was based on the four basic sanitary landfill conditions proposed by Thurgood et al., 1998 and we rated this measure very low because none of the conditions is met in both cities. Table 6 shows the criteria we used in assessing this aspect. A summary of the rates of all the measures under this objective is provided in Table 7.

Table 6 Scoring Criteria

The Four Basic Conditions for a Landfill to be Sanitary		**Score for Both Cities**		**Average Score**
		Yes	**No**	
1. Full or partial hydrogeological isolation	Leachate collection system	1	0	
	Leachate treatment system	1	0	
2. Formal engineering preparations	Waste disposal plan	1	0	
	Final restoration plan	1	0	
3. Permanent control	Trained supervision staff based at site	1	0	
4. Planned waste emplacement & covering	Layering & compacting	1	0	
	Daily covering	1	0	
Total average score				
Rate				**1 (very low)**

Table 7 Rating for Extent of Solid waste Management in the Major Cities

Measure	Data LL	Mz	Rate (Average for both cities)
3.1 Waste Collection rate	30%	30%	2
3.2 Industrial solid waste disposal compliance	All waste dumped without categorization	All waste dumped without categorization	1
3.3 Sanitary condition of final disposal facilities	Open dumping	Open dumping	1
Overall Indicator Rate			**1.3 (very low)**

Overall rate for this indicator is very low showing that solid waste management in the major cities in the lake basin is very weak.

4.4 Summary of Findings

In summary, our findings show very weak control of point source pollution and moderate control of nonpoint source pollution in the lake basin. We also find that solid waste management in the major cities in the basin is very weak. Table 8 presents the summarized scores. Overall, waste management and pollution control in the lake basin is very weak.

Table 8 Summary of Indicator Rates

Indicator	Rate
1. Degree of Point Source Pollution Control	1
2. Degree of non-point Source Pollution Control	3
3. Extent of solid waste management in the cities	1.3
Overall Rate (average)	**1.8**

5. How Can Synergies Be Harnessed for Better Lake Basin Management?

The findings show very weak control of point source pollution and this is mainly attributed to the weak capacity of institutions that are responsible for managing wastewater. For general point source pollution control, indications show weak capacity for monitoring and enforcement of regulations by the institutions with mandate e.g. the Department of Environmental Affairs. These challenges are due to low staffing levels in the institutions and insufficient resources and equipment.

For non-point source pollution control, the major challenges are weak coordination among sectors especially at local level of implementation. All the main sectors of concern in our study in this regard (forestry, fisheries and agriculture) have local community institutions in place responsible for management of local resources. However, we observed that there is no cross-sector cooperation among these local institutions. Considering the fact that there are some cross-cutting activities that would be better managed jointly at the local level, this may be an opportunity that is not being embraced and thereby losing some synergies that could be harnessed. For example, river bank protection activities are one area where joint implementation by farmer clubs, forestry management clubs and fisherfolk clubs can be pursued. There is need to make local people aware of how linked and interdependent their various activities are and why joint effort is required to ensure sustainability of the lake basin and their well-being. This needs to be encouraged by the relevant institutions e.g. the Ministries and Departments of Agriculture, Forestry and Fisheries. This also requires traditional leaders in the communities to play a role of helping their subjects see the bigger picture and encouraging them to work together for mutual benefit.

Challenges leading to the very weak management of solid waste management may be attributed to weak institutional capacity resulting from insufficient resources and equipment. More importantly, this may also be due to weak participation of stakeholders and communities/households in overall waste management. Both city councils have plans to promote stakeholder participation in managing waste at source, recycling and other aspects of waste management. LCC for example, indicated that they are to implement their plans by 2016. There is need for the city councils to vigilantly implement their plans so that overall solid waste management may be improved as soon as possible.

It has been shown that most of the main challenges are boiling down to weak institutional capacity and ultimately insufficient resources and equipment. Figure 4 shows a causal loop diagram that figuratively portrays the linkages among the main challenges and issues, and important action points if the situation is to be improved.

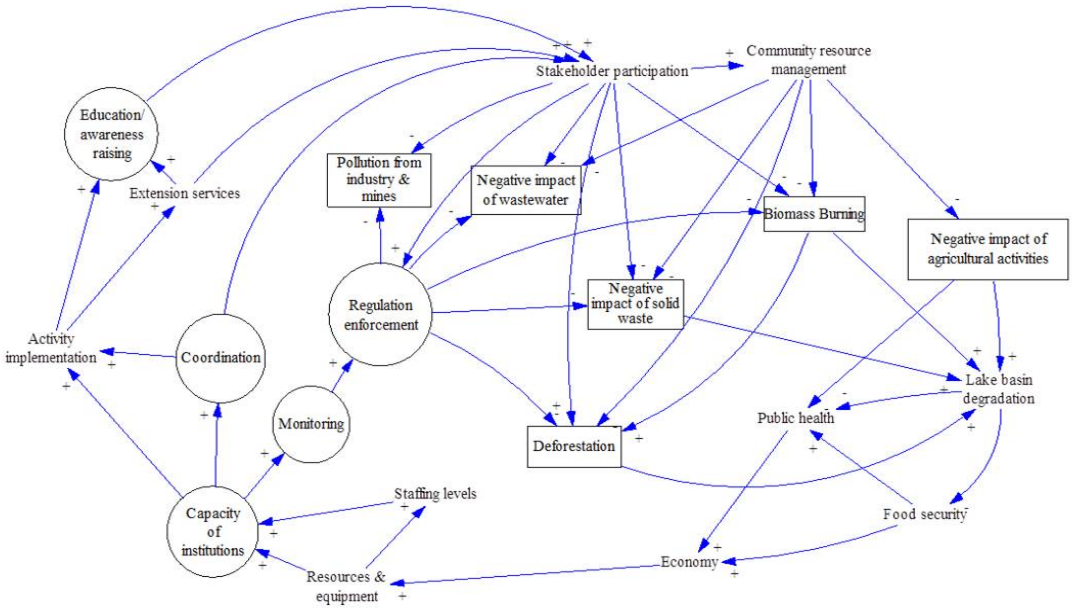


Figure 4 Causal loop diagram showing the interaction of challenges and issues in the Lake Malawi Basin
The items in boxes are the main issues in the lake identified by previous researchers, items in circles are the main challenges identified in this study and the remaining items are factors that are interacting to affect the main challenges and issues.
The item at the tail of the arrow causes a change in the item at the head of the arrow. A + sign at the head of the arrow indicates that change occurs in the same direction and a – sign indicates that change occurs in the opposite direction.

There are several loops in Figure 4 but we explain only one to aid understanding. A decrease in resources and equipment will result in a decrease in the capacity of institutions and this will cause a decrease in coordination among various institutions and stakeholders. In turn, stakeholder participation will decrease and result in a decrease in community resource management. This will cause an increase in the negative impact of agricultural activities and lake basin degradation will also increase. This will cause a decrease in food security and a decrease in the economy which will consequently cause a decrease in the availability of resources and equipment. This loop has a reinforcing effect i.e. we started with a decrease in resources and equipment and ended up with a more decrease in resources and equipment. This effect indicates that a change in resources and equipment leads to an amplified change when the effects are traced around the loop (similarly, if there is an increase in resources, it will lead to more resources being available if we trace the effects around the loop).

From the loop diagram, we identified three main factors as the main action points to better harness synergies for attaining sustainable management and utilization of the lake basin. These action points are stakeholder participation, regulation enforcement and capacity of institutions. These factors are either affecting many other factors, or are being affected by many factors or both. If efforts concentrate at improving these areas, overall waste management and pollution control will improve and consequently, lake basin management will be more sustainable. Ultimately, all these three action points are affected by availability of resources. Therefore, ensuring that sufficient resources are available to the various mandated institutions is crucial for sustainable lake basin management. One very key factor in realizing this is support of political leaders as they play a very important role in setting priorities. Muhandiki and Ballatore (2007) pointed out that "For lake basin management to be successful, it is important to cultivate political will, support, and commitment at the highest political level". Table 9 presents the actions we recommend under each of these main action points. It should be noted however that our list of recommended actions is meant to act as a guide and is not exhaustive.

Table11 Recommended Actions

Action Point	Recommended Actions
Stakeholder participation	1. Raise awareness 2. Strengthen coordination among related institutions & other stakeholders 3. Strengthen extension services 4. Pursue integrated implementation of activities at local level (encourage inter-sectoral interaction of local community institutions) 5. Encourage alternative financing mechanisms where feasible e.g. "Payment for Ecosystem Services (PES)" etc.
Regulation enforcement	1. Strengthen monitoring capacity & encourage participation of the general public 2. Bring offenders to book to discourage potential offenders 3. Revise regulations as necessary
Capacity of institutions	1. Ensure sufficient & timely Government funds for institutions 2. Explore innovative ways of accessing supplementary funds e.g. PES, co-management practices, Public Private Partnership (PPP) etc.

6. Conclusion.

We find that overall, waste management and pollution control in the Lake Malawi Basin is very weak and threatens the sustainability of water resources in general and the lake Malawi basin in particular. This poses possible consequences on the well-being of Malawians and the economy of the country. There is need to improve capacity of institutions, enforcement of regulations and stakeholder participation. Availability of sufficient resources is necessary to improve the situation and support of political leaders is needed to ensure that resources are available for the country to move towards sustainable management and utilization of water resources and the lake basin.

Acknowledgement
We greatly appreciate the support and cooperation from the various institutions in Malawi that we consulted during our study.

References

Bootsma, H.A., & Hecky, R.E. (1999). Lake Malawi/Nyasa – An African Great Lake and Great Resource. In *Water Quality Report, Lake Malawi / Nyasa Biodiversity Conservation Project,* eds. Harvey A. Bootsma and Robert E. Hecky, 17-28. SADC / GEF.

Bootsma, H.A., & Hecky, R.E. (2003). A Comparative Introduction to the Biology and Limnology of the African Great Lakes. *Journal of Great Lakes Research 29(Suppl. 2), 3-18.*

Chafota, J., Burgess, N., Thieme, M. & Johnson, S. (2005). Lake Malawi/Niassa/Nyasa Ecoregion Conservation Programme: Priority Conservation Areas and Vision for Biodiversity Conservation. WWF-SARPO.

Falkenmark M., Andersson, L., Castensson, L. & Sundblad, K. (1999). *Water: A Reflection of Land Use.* Stockholm: Swedish Natural Science Research Council.

Government of Malawi, GoM. (2008). *Integrated Water Resources management and Water Efficiency Plan.* Ministry of Water Development and Irrigation.

Government of Malawi, GoM. (2010). *Malawi State of Environment and Outlook Report: Environment for Sustainable Economic Growth.* Ministry of Natural Resources, Energy and Environment.

Government of Malawi, GoM. (2011). *Statistical Yearbook.* National Statistical Office.

Msilimba, G. & Wanda, E.M. (2012). Wastewater Production, Treatment and Use in Malawi: National Report. Paper Presented at the Third Regional Workshop 'Safe Use of Wastewater in Agriculture', Johannesburg, South Africa, September 26-28.

Muhandiki, V.S. & Ballatore, T.J. (2007). Effective lake basin management institutions: lessons from African lakes. *Water Science & Technology, Vol 56 No 1, pp 189–198.*

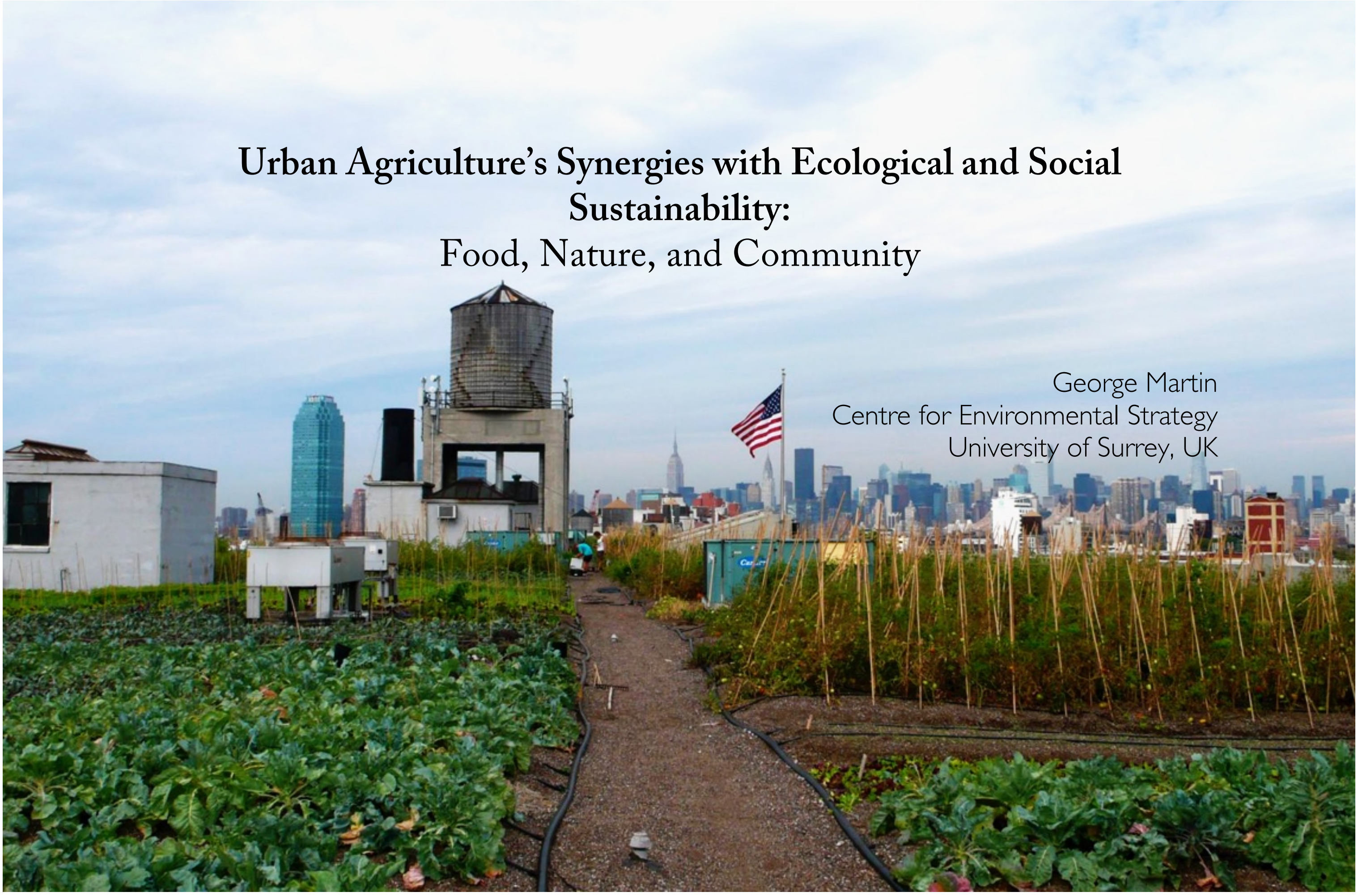
Pérez-Foguet, A., & Garriga R. (2011). Analyzing Water Poverty in Basins. *Water Resources Management, 25, 3595–3612.*

Thurgood, M., Rushbrook, P., & Pugh, M. (1998). *Decision-maker's guide to solid waste landfills - Summary.* Washington, D.C.: The World Bank.

United Nations Human Settlements Programme, UN-HABITAT. (2011). *Malawi: Lilongwe Urban Profile.* UN-Habitat-Regional and Technical Cooperation Division. Nairobi: Kenya.

Yamada, S., & Muhandiki, V., (2007). Urban Diffuse Pollution and Solutions in Japan. In *Cities of the Future: Towards Integrated Sustainable Water and Landscape Management, eds.* Vladmir Novotny and Paul Brown, 157-173. London: IWA Publishing.

Urban Agriculture's Synergies with Ecological and Social Sustainability:
Food, Nature, and Community



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Abstract

The practice of urban agriculture (UA) is a flourishing topic in environmental discourse based on its promise for increasing sustainable food production in a world increasingly urbanized at the same time food security is threatened by climate change. Research indicates UA has potential for a substantial contribution to food sustainability in the global South where extensive poverty and large populations with traditional agricultural knowledge provide the material and social bases for growing an already appreciable level of production. However, UA may have a low ceiling in the global North due to the high value of land and the lack of unpolluted soil (a legacy of industrial production). It has been argued that UA in the global North can overcome this lack of affordable arable land by constructing vertical farms and expanding the production of current venues: allotments, kitchen gardens, community gardens, and peri-urban farming. This paper considers these arguments based on a case study of a community garden in New York City, supplemented by data from other studies. The conclusion is that the potential for UA in the global North will likely remain low. Still, it merits policy support on other grounds: its synergies with ecological and social sustainability. While UA may offer somewhat greater capacity to enhance ecological sustainability than other green spaces, its synergies with social sustainability are more substantial—generating social capital for community development, promoting environmental education, and advancing environmental justice. These synergies warrant increased attention in urban sustainability research.

"The garden is the smallest parcel of the world and then it is the totality of the world."
Michel Foucault (1986:26)

Introduction: Parsing the Potential of Urban Agriculture

My basis for parsing the potential of urban agriculture in this paper this is experiential as well as empirical: The experience comes from over a decade of participation in a community garden in New York as well as occasional workdays on friends' allotments here in the UK. Much earlier on, I grew up in a semi-rural environment in Kentucky.

My local community garden in Manhattan, the WSCG occupies 17,500 square feet (0.16 hectare) of rising land between two parallel streets. It is dominated by two features. At one end lies a large vegetable garden divided into 80-odd raised plots that are six feet by five feet in size. Six plots are reserved for school children. The small size of the plots considerably limits the scale of food production. Gardeners reported that produce served as occasional supplements to their tables. At the other end of the Garden is an amphitheater, which is used for a series of cultural productions throughout the summer season.

The Garden's 300-odd members and thousands of users were found to represent a cross-section of the neighborhood's population—with two major exceptions: Age and gender. Older women are disproportionately represented. Studies of other urban gardens have shown similar findings (Garnett 2001: 484; Sokolovsky 2009).

The Garden is now decades old, having been developed by neighborhood activists on a rubble-filled vacant lot. Although quite successful, it requires large amounts of labor to operate. The labor includes physical work like turning compost and administrative work like fund-raising.
This labor falls to a small cadre of gardeners—as one told me, "our problem is that only a core does everything--a dozen or so people." This is a common problem for community gardens, and the small core of active persons is not always sustained. A national survey of US community gardens found that "the primary reason given for loss of [hundreds of] garden sites is lack of interest by gardeners" (ACGA 1998:3).

Urban Agriculture: Back to the future?

It was the development of agriculture some 10,000 years ago that made cities possible and it has sustained their growth over the millennia. This sustenance is becoming problematic in an era when a majority of humans are for the first time residing in urban areas—at the same time as the species is dealing with global climate change. The principal threat to the human species from this climate change is to agriculture. The UN (2009; 2011) projects a global population in 2050 of 9 billion, 70 percent of whom will live in cities. This population will require about 70 percent more food that the 2009 population. Meanwhile, expanding cities coupled with the floods and droughts expected from global climate change will reduce the store of arable land. The upshot of these changes is that our species must enhance its food production on a large scale, and do so in a sustainable fashion.

Gardening in urban areas has led to a full-blown movement which has acquired its own categorical identity—Urban Agriculture (UA). Thus, McClintock (2010: 191) argues,

> As we find ourselves once again in the throes of a crisis of capitalism, the popularity of UA in the Global North has surged and the discourse surrounding it has shifted from one of recreation and leisure to one of urban sustainability and economic resilience. Even the terms used to describe it have shifted in the Global North; "urban agriculture" is replacing "community gardening" in everyday parlance' placing it (despite its much smaller scale) in the same category as UA in the Global South . . . .

Of course, urban agriculture is as old as cities but what is the future of its revival? The potential of UA can be analyzed using three vectors of sustainability—food (or agricultural); ecological (or environmental); and social (or community).

Food Sustainability

The primary focus in UA is on cities of the global South, and with good reason—it is far more widely practiced there. The results of one comparative research project (Zezza and Tasciotti 2010) found that in cities in 11 of 15 countries (in Africa, Asia, Eastern Europe, and Latin America), the share of households participating in food production was over 30 percent. Participation was concentrated in the poorest strata of populations, with over 50 percent of the poorest quintile participating in 8 of the 15 nations. UA's contributions to total agricultural production ranged from a high above 20 percent in Madagascar and Nicaragua, to a low of 3 percent in Malawi. In only 4 nations was more a one-third of agricultural production marketed. A significant additional finding of this research was that urban agriculture was associated with indicators of dietary adequacy and diversity in a majority of the nations.

As to the potential of UA in the global South, the researchers concluded:

> On the one hand, the potential for urban agriculture to play a substantial role in urban poverty and food insecurity reduction should not be overemphasized, as its share in income and overall agricultural production is often quite limited. On the other hand, though, its role should also not be too easily dismissed, particularly in much of Africa and in all those countries in which agriculture provides a substantial share of income for the urban poor, and for those groups of households to which it constitutes an important source of livelihoods (Zezza and Tasciotti 2010: 255).

Thus, at present UA has a reasonable potential to be a significant food producer for the poorest people living in the poorest cities of the world, and it is receiving enhanced attention from climate change analysts. For example, at Rio+20, Altieri (2012) made a case for a considerable scaling-up of urban agroecology in the South.

What about the potential role of urban agriculture in producing food in cities of the global North?

Summaries of four pieces of research from two countries show the following:

> --London could produce 18 percent of the fruit and vegetables eaten by its residents (Garnett 2001)
> --Oxford could produce one-half of its fruit and vegetables (*FoodPrinting Oxford* 2012)
> --Cleveland, Ohio, 11 percent of food and beverage consumption by weight and 4.5 percent by expenditure could be produced (Grewal and Grewal 2012)
> --Oakland, California has a potential for vegetable production of 5 percent of current vegetable consumption (McClintock *et al.* 2013)

These percentages are much higher than present production in these cities—Cleveland, for example, has the potential to produce more than 100 times its current level of food and beverage consumption. However, the percentages for potential production remain low and do not approach food sustainability. Thus, in Oxford, the potential of producing 50 percent of fruit and vegetables would represent only 2 percent of the city's overall requirement for land to feed itself. Moreover, these maximum potential figures are even less impressive if the following is considered:

> --We are looking only at fruit and vegetable production, which is a minority share of the human diet
> --Even when that share is upgraded, as in the UK Eatwell Plate (FSA 2010), to one-third of a recommended sustainable dietary allowance, the result would be that London has a maximum potential of producing only about 6 percent of its total food needs

Additionally, there are major obstacles to reaching the potential production levels. The first is that an unknown portion of the land that would be converted to agriculture is too contaminated to sustain food production for humans. For example:

> --Nearly 60 percent of London's vacant industrial land is contaminated and that even many allotments, domestic gardens, and other small pockets of land are too polluted for safe food production
> --A study that assessed the lead contamination of soil in 12 vacant sites in Oakland, California, found a high level of site variability that must be taken into consideration when planning for urban farming; significantly, sites with contamination significantly higher than the Federal screening level were in predominantly low-income and African American neighborhoods, indicating a major environmental justice concern (McClintock 2012)

The other obstacle to greater urban food production is the land squeeze. Food production is land intensive and urban land has high commercial value and economic competition for its use. Thus, they feature skyscraper buildings. For example, two-thirds of the original lot rehabilitated by the WSCG was eventually taken by residential apartment buildings. The negotiation of conflicting land stakeholder interests is quite intense in many cities of the North, New York and London being prime examples.

Meanwhile, these cities struggle even to maintain their current levels of green space. For example, in London, the domestic gardens, which comprise 25 percent of the land upon which fruit and vegetables could be grown, are declining. A recent study (Smith 2010) found that between 1998 and 2008, their area had declined by 12 percent. It is primarily being lost to paving for parking cars.

Vertical Farming?— One idea to overcome the lack of arable land in cities of the North which is gaining traction is vertical farming, or high-rise structures devoted to food production (see Despommier 2009). These urban farms would use new, sustainable greenhouse technologies in order to mass-produce food, including fish and perhaps even poultry. Although not a new idea, such a skyscraper has yet to be built.

Chicago is an example. There, a "mega" indoor vertical farm is being converted from an abandoned warehouse. *FarmedHere* as it is called is located in the suburbs and has 90,000 square feet in which to produce a million pounds a year of organic greens. The plant proposes to integrate aquaponics by using tanks of fish to clean water and provide fertilizer for the soil-less crops. It is a business that started with loan from the massive US organic food store chain, Whole Foods (FCRN 2013). Though large in floor space, this structure is only two stories tall. The goal of building a skyscraper for food production has yet to be met.

There are two major obstacles to achieving this goal. One obstacle is economic; *i.e.*, the high costs of skyscrapers. Currently, their costs are borne by corporations and governments for their offices, and by middle-to-upper class residents for their homes, or state-subsidized housing for lower-income citizens. The costs are for land, for construction (or conversion), for maintenance, and for taxes. Then there are the energy and labor costs of growing food. It appears quite problematic that a successful business model for skyscraper food production would include very high costs for its output.

In addition to economic obstacles, there are major presumptive questions about the sustainability of vertical farms. Energy will be required to get adequate artificial light to plants that are not at windows on all the floors of high structures in order to replace sunlight. The proponents of vertical farming recognize this sustainability issue. Dickson Despommier, its best-known advocate, has been quoted as saying that "powering farms is still the biggest hurdle for the industry" (*Chicago Impact* 2013: 2). The consensus of technology experts at an international meeting on vertical farming at the University of Maryland in 2012 was that there is a bottleneck in the development of more efficient LED lighting, which is now about one-half of what it needs to be to make such farming economically feasible (*The Vertical Farm* 2013).

At least in the near and mid-term, vertical farming appears to have low potential for making a major contribution to sustainable urban food production.

Scaling-Up Present Urban Farming? —Even if its food sustainability production prospects low, UA can still make a material contribution to the lives of some sub-groups in some cities of the global North—for example, for low-income immigrants with access to land, as the work of Mares and Pena (2010) indicate for community gardens in Los Angeles and Seattle. In both cases, the gardens were large ones (14 and 4 acres) and the immigrants came from agricultural backgrounds.

A best-case scenario for growing the scale of urban farming has been developed for Detroit, a distressed city which today has sizeable acreage of the vacant, publicly-owned land that would be required for the purpose (Colasanti *et al.* 2010). The scenario is based on the following assumptions:

--Soil would be non-contaminated or de-contaminated
--Field harvest could be stored as well as consumed immediately
--The growing season would be extended by using "hoop houses" (passive-solar greenhouses made with plastic sheeting stretched over metal frameworks)

In this scenario, it would be possible to supply a significant portion of the fruit and vegetables consumed locally—about 75 percent of vegetables and nearly 50 percent of fruits.

However, there are caveats to this scenario:

> --If Detroiters increased their fruit and vegetable consumption to government-recommended and sustainable dietary allowances, three times as many acres would be required
> --The significantly scaled-up gardening would require substantially more human labor, the source of which is unknown

That is the story at the moment for sustainable food production in cities of the North. What about the ecological and social sustainability vectors of UA?

Ecological Sustainability

All urban green spaces, including gardens, enhance natural environments is a number of significant ways (see Bousse 2009; RHS 2011):

> --Contributing to biodiversity through sustaining a variety in flora and fauna
> --Contributing to species preservation by providing food and habitat
> --Reducing soil erosion and retarding flooding
> --Mitigating the urban heat island effect

While community gardens likely are no better than other urban green spaces in providing these contributions to ecological sustainability, they are more likely to provide opportunities to link ecological and social sustainability; for example in environmental justice projects.

Thus, Palamar's (2010) case study of New York's Green Guerrillas illustrates the possibilities of for integrating ecological restoration and environmental justice within an urban setting. Additionally, in a study of community gardens in the San Francisco Bay area, Ferris *et al.* (2001: 567) concluded, that "community gardens can be very positively linked to the implementation of Local Agenda 21 and sustainability policies and at the same time used to promote environmental equity."

Social Sustainability

As to social sustainability, UA offers a range of contributions--in health, education, and community development (see Relf 1992). With regard to health, gardens provide locally-accessible and free opportunities for both physical and mental well-being. Gardening is by nature a physical pursuit. Its physicality ranges from the fine motor involvement of cutting flower stems to the aerobic gross motor tasks of turning a compost pile (Brown and Jameton 2000: 28, citing Mattson 1992). While gardening has positive consequences for physical health, it also "has been observed to be a way to relax and release stress" (Brown and Jameton 2000: 28). Thus, in addition to promoting physical health, gardens can support mental health—for their users as well as their gardeners. They provide a small plot of nature for people living in large and dense cities, access to which can be a form of therapy allowing for solitude, escape, serenity, and reflection. Such access has been found to be related to mental health by mitigating a psychological "nature deficit disorder" (Louv 2008).

It is with regard to education that community gardens may make their most significant contributions. The educational programs they provide for school children can be a vehicle through which coming generations are provided a structured opportunity to learn-by-doing some of the basic principles of ecological sustainability. Thus, in the WSCG, classes from nearby schools engage over the course of a term in sustainable agricultural practices such as working compost bins and growing organic vegetables. These classes have led to the creation of a small garden at the primary school across the street.

It is in community development that community gardens have received the most attention. They have been found to "contribute to neighborhood satisfaction, sense of community belonging, and social contacts" (Comstock *et al.* 2010, citing Clayton 2007; Kearney 2009). They have also been found to enhance community pride and serve as an impetus for broader community improvement by improving relationships among people (Comstock *et al.* 2010, citing Wakefield *et al.* 2001).

One study of an urban multi-ethnic area concluded that the social benefits of any public open space are to "provide relief from daily routines, sustenance for people's sense of community, opportunities for sustaining bonding or making bridges, and influence tolerance and raise people's spirits" (Cattell *et al*. 2008: 544). Finally, UA has been found to create opportunities for leadership development and community organizing and in this way contributes to neighborhood social capital (Brown and Jameton 2000: 29).

The social capital manifested in urban gardens is mobilized through political activity and they have become meaningful arenas for political action. Community gardens are increasingly landscapes that support and connect three vital spheres of political mobilization: Environment, food, and space. For example, a study of community gardens in Toronto by Baker (2004: 306) argues that: "By digging into their small plot of land, gardeners are challenging conventional ideas of urban planning and design, working on community-development projects, engaging with place-based social movements, and creating alternative food systems."

In Canada, an emergent community food-security movement aims to cultivate democratic food practices by raising awareness of where food comes from and by promoting locally grown food. This practice has as a model, "Food Citizens," who not only are consumers but also who are engaged in their communities and have an intimate connection to their food (Baker 2004:306; Welsh and MacRae 1998). Another framing of the new connections between urban space and food is that of "civic ecology" (Tidball and Krasny 2007: 158), a term that embraces the management of nature, public education, and community development within urban settings.

Conclusion: Maximizing the Food, Ecological, and Social Sustainability of Urban Agriculture

While there is potential for increasing UA, it is probable that this will occur in the global South. There, widespread and deep poverty creates a material need and social basis for enhancing the already appreciable level of urban food production. Also, Altieri (2012: 17) noted also that "the reason why the potential resides in the South and not in the North is because in developing countries still resides a large peasant-indigenous population, with a rich traditional agricultural knowledge and a broad genetic diversity which conforms the basis of resilient diversified agroecosystems."

In the global North, UA has the potential to increase but its ceiling appears low due to the commercial value of real estate, a lack of safe land for growing food, the sheer amount of land needed to produce food, and questions about its energy sustainability. At least in the foreseeable future, the best prospects for any vertical farming lie in turning the spaces on the rooftops of urban buildings into gardens. This would require no new land and no energy for artificial light.

One model of the city for expanding food production is the regional or ecosystem approach. The ecological region focuses on the natural sustainability of urban agglomerations through the preservation of ecologically significant land such as wetlands, and the redevelopment of a regional agriculture (Luccarelli 1995). A schematic for a zonal scaling of agriculture in urban agglomerations might look like the following:

1. Core or inner city: Some fruit and vegetables. Continue to develop community gardens but direct the focus to social sustainability.
2. Suburbs: Even more fruit and vegetables, possibly with some poultry (meeting both public health and sustainability concerns). Expand allotment systems.
3. Exurbs: Small farms producing fruit, vegetables, and poultry that are taken to farmer's markets in the inner city.
4. Periphery: Small and medium size farms producing fruit, vegetables, poultry, pork, and dairy, the produce of which is marketed through retail outlets across the urban agglomeration.

Even assuming such a zonal scaling and a considerable increase in food production, UA will not be able to produce at least two groups of food, one that is a necessity—that is the food that requires large-scale land use, including all grains—and one that is discretionary—that is the exotic components of modern urban diets; for example, bananas and citrus in cities like London and New York.
In conclusion, the potential of the contemporary upsurge in urban agriculture is assessed as follows:

1. Agricultural (food): Limited potential and concentrated in the provision of fruit and vegetables, and in the South

2. Ecological (environmental): Meaningful potential but no more so than other urban green spaces except for synergies with social sustainability
3. Social (community): Substantial potential, especially in the mobilization needed for furthering education for sustainability and environmental justice

These considerations are by nature preliminary. We have a lot of questions about urban food production and a dearth of information. This means that UA can be the basis of a rich research agenda. In terms of knowledge we are probably at the end of the beginning of this research agenda.

Finally, whatever their agricultural, ecological, and social assessments, it needs to be said that urban gardens are also important resources for the personal lives of city dwellers.

Like all urban gardens, the WSCG is only a very small piece of nature in a very large city, but like all of nature it "has unusually potent power to heal broken human landscapes and to humanize and reinvigorate distressed cities and built environments . . . to restore community and hope at the same time that urban ecosystems are repaired" (Beatley 2011: 9).

The garden is indeed a "totality" for urbanites—providing for community solidarity, for a direct connection to nature, and for **some** food.

References

ACGA. 1998. "National Community Garden Survey." Philadelphia: American Community Garden Association.

Altieri, Miguel A. 2012. "The scaling up of agroecology: spreading the hope for food sovereignty and resiliency." Rio+20 Position Paper, *Sociedad Cientifica Latinoamericana de Agroecologia* (SOCLA). < http://www.agroeco.org/socla>

Baker, Lauren E. 2004. "Tending Cultural Landscapes and Food Citizenship in Toronto's Community Gardens." *Geographical Review* 94: 305-325.

Beatley, Timothy. 2011. *Biophilic Cities: Integrating Nature into Urban Design and Planning*. Washington, DC: Island Press.

Bousse, Yannick Steven. 2009. "Mitigating the urban heat island effect with an intensive green roof during summer in Reading, UK." Reading: MSc Dissertation, Urban Sustainability, Reading University.

Brown, Kate H. and Andrew L. Jameton. 2000. "Public Health Implications of Urban Agriculture." *Journal of Public Health Policy* 21: 20-39.

Cattell, Vicky, Nick Dines, Wil Gesler, and Sarah Curtis. 2008. "Mingling, observing, and lingering: Everyday public spaces and their implications for well-being and social relations." *Health & Place* 14: 544-561.

Chicago Impact. 2013. "'Mega' Indoor Vertical Farm: Chicago Suburb New Home to Nation's Largest Such Facility." *Huff Post*, April 18. <http://www.huffingtonpost.com/2013/03/28/mega-indoor-vertical-farm>

Clayton, S. 2007. "Domesticated nature: motivations for gardening and perceptions of environmental impact." *Journal of Environmental Psychology* 27: 215-224.

Colasanti, Kathryn, Charlotte Litjens, and Michael Hamm. 2010. "Growing Food in the City: The Production Potential of Detroit's Vacant Land." East Lansing: The C.S. Mott Group for Sustainable Food Systems, Michigan State University.

Comstock, Nicole, L. Miriam Dickinson, Julie A. Marshall, Mah-J. Soobader, Mark S. Turbin, Michael Buchenau, and Jill S. Litt. 2010. "Neighborhood attachment and its correlates: Exploring neighborhood conditions, collective efficacy, and gardening." *Journal of Environmental Psychology* 30: 435-442.

Despommier, Dickson. 2009. "The Rise of Vertical Farms." *Scientific American* 301: 60–67.

FCRN. 2013. "Vertical farming: World's largest indoor vertical farm opens." Oxford: Food Climate Research Network. http://www.fcrn.org.uk/research-library/agriculture/vertical-farming

Ferris, John, Carol Norman, and Joe Sempik. 2001. "People, Land and sustainability: Community Gardens and the Social Dimension of Sustainable Development." *Social Policy & Administration* 35: 559-568.

FoodPrinting Oxford. 2012. *FoodPrinting Oxford: How to feed a City*. Oxford: Low Carbon Oxford/LandShare.

Foucault, Michel. 1986. "Of Other Spaces." Tr. Jay Miskowiec. *Diacritics* 16: 22-27.

FSA. 2010. "Your guide to the eatwell plate." London: Food Standards Agency. <http://www.food.gov.uk/multimedia/pdfs/publication/eatwellguide0310.pdf>

Garnett, Tara. 2001. "Urban Agriculture in London: Rethinking Our Food Economy." Pp. 477-500 in N. Bakker, M. Dubbeling, S. Guendel, U. Sabel Koshella, and H. de Zeeuw, eds., *Growing Cities, Growing Food: Urban Agriculture on the Policy Agenda*." Feldafing: DSE (*Deutsche Stiftung fur international Entwicklung*).

Grewal, Sharanbir S. and Parwinder S. Grewal. 2012. "Can cities become self-reliant in food?" *Cities* 29: 1-11.

Kearney, A. 2009. "Residential development patterns and neighborhood satisfaction: impacts of density and nearby nature." *Environment and Behavior* 38: 1112-1139.

Louv, R. 2008. *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*. Chapel Hill, NC: Algonquin Books.

Luccarelli, Mark, 1995. *Lewis Mumford and he Ecological Region: The Politics of Planning*. New York: The Guilford Press.

Lyson, Thomas A. 2004. *Civic Agriculture: Reconnecting Farm, Food, and Community*. Medford, MA: Tufts University Press.

Mares, Teresa M. and Devon G. Pena. 2010. "Urban agriculture in the making of insurgent spaces in Los Angeles and Seattle." Pp. 241-254 in J. Hou, ed., *Insurgent Public Space: Guerrilla Urbanism and the Remaking of Contemporary Cities*. London and New York: Routledge.

Mattson, R.H. 1992. "Prescribing Health Benefits through Horticultural Activities." Pp. 161-168 in D. Relf, ed., *The Role of Horticulture in Human Well-Being and Social Development: A National Symposium*. Portland, OR: Timber Press.

McClintock, Nathan. 2012. "Assessing soil lead contamination at multiple scales in Oakland, California: Implications for urban agriculture and environmental justice." *Applied Geography* 35: 460-473.

-----. 2010. "Why farm the city? Theorizing urban agriculture through a lens of metabolic rift." *Cambridge Journal of Regions, Economy and Society* 3: 191-207.

McClintock, Nathan, Jenny Cooper, and Snehee Khandeshi. 2013. "Assessing the potential contribution of vacant land to urban vegetable production and consumption in Oakland, California." *Landscape and Urban Planning* 111: 46-58.

Palamar, Colette. 2010. "From the Ground Up: Why Urban Ecological Restoration Needs Environmental Justice." *Nature and Culture* 5: 277-298.

Relf, D., ed. 1992. *The Role of Horticulture in Human Well-Being and Social Development: A National Symposium*. Portland, OR: Timber Press.

RHS. 2011. "Gardening matters: Urban gardens." London: Royal Horticultural Society.

Seto, K., Fragkais, M., Guneralp, B., and Reilly, M. (2011) "A Meta-Analysis of Global Urban Land Expansion," *PLoS ONE* 6. Doi:10.1371/journal.pone.0023777. (accessed 15 May 2013).

Smith, Chloe. 2010. "London: Garden City?" London: London Wildlife Trust.

Sokolovsky, Jay. 2009. "Elders, Urban Community Greening and the Rise of Civic Ecology." Pp. 453-486 in J. Sokolovsky, ed., *The Cultural Context of Aging*. 3rd ed. Westport, CT: Praeger.

The Vertical Farm. 2013. "International Meeting on Vertical Farming." <http://www.verticalfarm.com/blog>

Tidball, K. and M. Krasny. 2007. "From risk to resilience: what role for community greening and civic ecology in cities." Pp. 149-160 in A. Wals, ed., *Social learning towards a more sustainable world: Principles, perspective, and praxis*. Wageningen, Netherlands: Academic Publishers.

UN. 2011. *World Population Prospects, The 2010 Revision*. New York: Department of Economic and Social Affairs, United Nations.

UN. 2009. *Planning Sustainable Cities—Global Report on Human Settlements*. Nairobi: UN-Habitat.

Wakefield, S.L., S.J. Elliott, D.C. Cole, and J.D. Eyles. 2001. "Environmental Risk and (re)action: air quality, health, and civic involvement in an urban industrial neighborhood. *Health & Place* 7: 163-177.

Welsh, J. and R. MacRae. 1998. "Food Citizenship and Community Food Security: Lessons from Toronto, Canada." *Canadian Journal of Development Studies* 19: 237-255.

Zezza, Alberto and Luca Tasciotti. 2010. "Urban agriculture, poverty, and food security: Empirical evidence from a sample of developing countries." *Food Policy* 35: 255-273.

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An Analysis of the Comprehensive Effectiveness of Tokyo's Climate Policies

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Abstract

This paper focuses on two Tokyo climate initiatives, which aim to meet climate change mitigation measures, such as carbon reduction targets and energy efficiency measures. The first initiative is the Tokyo Cap and Trade Program, which was launched in April 2010 by Tokyo Metropolitan Government (TMG). This was the world's first cap-and-trade programme that included facilities in the public, commercial, and industrial sectors (TMG, CCS 2007). While the Tokyo Cap and Trade Program focuses on CO2 reduction by restricting energy consumption, the Tokyo Green Building Program focuses on energy efficiency measures that employ environmentally friendly design principles. Both initiatives have a multiplier effect that meets the overall low-carbon and energy efficient objectives established by the city. These initiatives significantly contribute to demand-side management efforts to reduce energy consumption and change human behaviours, thus raising the awareness of a range of stakeholders and users. Alongside the difficult energy issues incurred by the 2011 earthquake and tsunami that hit Japan, energy management and decentralised energy systems employing renewable energy have been strongly emphasised. Even though local climate change policies are limited by, the resources and powers of local government, these climate initiatives should be expected not only to promote climate mitigation measures, but also to create fundamental social structural changes including governance and institutional frameworks and even funding mechanisms. Therefore, this paper attempts to explore co-benefits and find the linkage across climate policies, planning policies, and other social factors.

Keywords: Climate Change, Sustainable Development, Energy Efficiency

1. Introduction

Tackling climate change is an inevitable factor in ensuring the world's long-term future. The increasing efforts of global warming can no longer be ignored. Most of governments throughout the world have already made significant efforts to improve energy efficiency, establish and realise carbon reduction targets, and protect energy security for projected increases in demand.

Tokyo is located in the central main island in Japan, has a population of approximately 13 million, and a land area of 2,188 square kilometers.

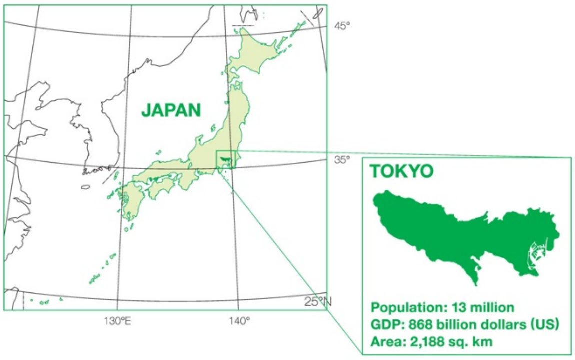

Figure1.1: Tokyo Facts
(Source: Tokyo Metropolitan Government, 2007)

Under a 10-year project started in 2007, Tokyo set a reduction target of 25 per cent for greenhouse gas (GHG) emissions below year 2000 levels by 2020 (TMG CCS 2007). As for per capita emissions, Tokyo is 20–30 per cent lower than London and New York. However, the GHG emissions in the Tokyo region are continuing to increase (TMG CCS 2007). The Tokyo region requires dynamic structural changes to meet reduction targets in each sector.

Tokyo Metropolitan Government (TMG) has implemented a number of mitigation strategies towards long-term climate change strategies. However, the effects of these policies have not been practically monitored. By focusing on two main climate change initiatives established by TMG, effective mechanisms and institutional patterns will be investigated.

In order to achieve target GHG emission mitigation and adaptation objectives, TMG must accelerate energy efficiency and renewable energy initiatives throughout the city. Energy efficiency and renewable energy initiatives on such a scale will require substantial amounts of capital and effective organisational structures. In addition, the linkages between sustainable development and climate change strategies should be considered in an urban context.

This paper aims to observe the good practice of climate change policy measures on a city scale. Governments have little experience in initiating change by using legislation, policies, and regulations (Girardet 1999). As for low-carbon infrastructure development relating to climate change, implementations are tailored to local situations. Thus, it is important to identify what circumstances and what type of stakeholders should be involved in each implementation.

By gathering feedback from a set of stakeholders, the overall effects and practicality will be assessed in a realistic approach to find pragmatic results in the short term. Subsequently, the long-term effectiveness of the measures implemented should be investigated.

2. Research Questions

What policies can succeed in delivering low-carbon and energy-efficient infrastructures in Tokyo?

Investigating two Tokyo city initiatives – the Tokyo Cap and Trade program and the Tokyo Green Building program

2.1 Key Questions

The list of the key questions that will be discussed in the report is shown below.

- What are the current climate policies for the deployment of energy efficiency and renewable energy in the Tokyo region?
- How important is planning for the strategic deployment of renewable energy and promoting energy-efficiency measures to meet climate mitigation targets in a Tokyo context?

3. Literature Review

3.1. Climate Change Strategy, World Overview and Cities

The Stern Review (2006) identified three sets of policy measures that are essential to shift the economy into low-carbon development. First, carbon pricing provides an economic incentive for key players to promote the transformation of the low-carbon market because it encourages players to minimise the impact associated with their investments and production on their economic well-being. Second, tailored technology support that enhances the performance and cost-effectiveness of new carbon-reducing technologies is necessary. In addition, this could create sufficient demand for new technologies. Third, experience regarding energy-efficiency opportunities should be shared more broadly beyond sectors and countries, which will require a shift from current institutional and behavioural patterns. These shifts can be promoted by specific policies and programmes. Therefore, tackling climate change and improving energy-efficiency requires a widespread and broad portfolio of climate-friendly technologies. On the supply-side, increasing quality, efficiency and scale – while reducing costs – is nessesary (Neuhoff 2011).

To achieve this, governments are likely to implement policies to enhance new carbon intensive technologies for achieving targets. These policy frameworks encourage private actors, which accelerate the implementation of new technology at affordable prices to the market. In addition, international cooperation can enhance such a long-term policy framework (Neuhoff 2011). However, while green economy tends to be encouraged in a climate policy context and sustainable development, Constable (2011) warns that there are supporting papers that estimate the transition to renewable energy will cause a significant amount of job loss over the twenty years. It must be noted that a purely market-driven process will not be able to promote the changes that are most needed; therefore, governments at the global, national, and local levels must create relevant policy frameworks to support sustainable social and economic activities. These points may not be able to be ignored when governments plan dramatic fundamental social system changes.

On the other hand, renewable energy resources can significantly minimise the risks of climate change caused by rising GHG, which are emitted in large part by the burning fossil fuels. Renewables can also reduce dependence on imports that might cause economic and political instability (Neuhoff 2004). Renewable technologies can already be cost-competitive provided a renewable plant is located in an area with sufficient resources and low-cost access to the grid (Ueta 2011).

In terms of the potential of decentralised energy systems to contribute to carbon savings and energy efficiency, Girardet (1999) stated the importance of comprehensive strategies for transforming cities; for example, the very density of urban forms offers opportunities for energy efficiency in transport access, home heating, and delivery of services. Local level policies can create much potential for specific urban transformations and social structural changes in local context, and policy implementation must be tailored very closely to local situations (Giradet 1999). Giradet also recommended the transferability of the best urban practices and flexibility of direct access to best practice examples through a dynamic system of decentralised co-operation between cities.

To promote decarbonisation on an urban scale, Rydin (2011) indicated that decentralisation of energy generation is a distinct practice and that a number of high-income countries that have heavily centralised systems tend to shift to decentralised systems. In this process, spatial planning and regulations can contribute to promoting greater decentralisation of energy systems. However, spatial planning and regulation are not enough, on their own, to ensure successful deployment of energy technologies. Energy systems have to be operationalized; thus institutional arrangements are significant as well as delivering reasonably priced energy alongside carbon reductions. Considering these institutional arrangements includes the range of stakeholders within spatial planning governance networks. The important point is that decentralised energy systems need – most importantly – to involve not only energy infrastructure providers, but also organisations to manage the infrastructures, which means communities and local business may be included within decentralised systems. (Rydin 2011).

3.2 Tokyo's Climate Change Strategy

TMG has set a GHG reduction target of 25% from the 2000 level by 2020. As the first step of its climate change mitigation strategy, TMG stated two principles. First, promotes reduced energy consumption by completing implementation of energy conservation programs as well as providing new building regulations. Second, it encourages the use of renewable energy and enhances the new energy market (TMG CCS 2007).

3.3 Current Status

3.3.1 Trends of Green Gas Emissions within Tokyo

Green gas emissions in Tokyo have increased by 3.3 per cent in 2005 compared to the 1990 levels. Carbon

Dioxide (CO2) dominated 96.3 per cent of emissions and increased 5.7 per cent from1990.

Greenhouse Gas Emissions in Tokyo (tentative values for fiscal 2005)
(supposing that electricity's CO_2 emission factor is fixed at the fiscal 2001 level of 0.318t-CO_2/MWh)

		Emissions (in Mt-CO_2 equivalent)			Growth from base year		Growth from previous year	
		Base year	FY2004	FY2005	Growth rate (%)	Growth amount (Mt-CO_2)	Growth rate (%)	Growth amount (Mt-CO_2)
Carbon dioxide (CO_2)	Industrial sector	9.9	5.4	5.6	-43.4%	-4.3	3.2%	0.2
	Business sector	15.8	20.2	21.0	33.0%	5.2	3.9%	0.8
	Residential sector	13.0	14.2	15.0	15.3%	2.0	6.2%	0.9
	Transport sector	17.9	20.1	19.3	7.7%	1.4	-4.0%	-0.8
	Other	1.0	1.0	1.0	-0.9%	-0.0	1.3%	0.0
	Total for CO_2	57.6	60.8	61.8	7.4%	4.3	1.7%	1.0
Total for other greenhouse gases than CO_2		3.4	2.3	2.2	-36.4%	-1.3	-5.6%	-0.1
Grand total		61.0	63.1	64.0	5.0%	3.0	1.5%	0.9

Table 3.1: CO2 Emissions in Tokyo (tentative values for fiscal 2005)
(Source: Tokyo Metropolitan Government, 2007)

As for the CO2 by sector, its percentage in the commercial sector has increased by seven per cent from 1990 to 2005 based on the composition ratio. Concerning the trends after 2000, the transportation and industrial sectors tend to decrease, while the commercial sector and household sectors indicate a continuous upward trend. Considering these trends, TMG has decided to take action to reduce CO2, particularly in the commercial and residential sectors (TMG 2008).

3.4.2 GHG emissions and Energy Consumption Trends for Tokyo

Energy-related carbon dioxide (CO2) accounted for around 95 per cent of GHG emissions in Tokyo. CO2 emissions in the city have increased, and energy consumption has also expanded ten per cent over the period. However, comparing FY2006 with FY2000, CO2 emissions in Tokyo decreased by two per cent and energy consumption decreased around four per cent (TMG 2010)

		Energy Consumption (PJ eq)				%		
		1990FY	2000FY	2005FY	2006FY	1990-2006	2000-2006	2005-2006
Energy Consumption (PJ)	Industry sector	129.1	96.5	80.7	76.3	-40.9%	-20.9%	-5.5%
	Commercial sector	182.6	245.2	273.4	266.2	45.8%	8.6%	-2.6%
	Residential sector	171.8	202.1	217.0	207.9	21.0%	2.9%	-4.2%
	Transportation sector	213.0	257.4	218.3	214.2	0.6%	-16.8%	-1.9%
	Total	696.4	801.3	789.4	764.6	9.8%	-4.6%	3.1%

Table 3.2: Energy Consumption by sector in Tokyo
(Source: Tokyo Metropolitan Government, 2010)

By energy type, electricity dominated approximately 50 per cent of CO2 emissions in Tokyo, followed by fuel Oil (28%) and city gas (17%). Since FY1990, the emissions of city gas steeply decreased due to the obvious shift from gas to fuel oil and other factors. CO2 emissions from the use of fuel oil and LPG have decreased by around 20 per cent. However, emissions from electricity use have increased around 15 per cent, along with city gas use (TMG 2010).

	CO_2 Emissions (10,000 t-CO_2eq)					Energy Consumption (PJ eq)				
	FY1990	FY2000	FY2006	1990-2006	2000-2006	FY1990	FY2000	FY2006	1990-2006	2000-2006
Fuel Oil	1,960	1,934	1,547	-21.1%	-20.0%	287	285	228	-20.6%	-20.0%
LPG	206	192	147	-28.6%	-23.4%	34	32	25	-26.5%	-21.9%
Manufactured Gas	680	926	976	43.5%	5.4%	137	187	199	45.3%	6.4%
Electricity	2,460	2,696	2,817	14.5%	4.5%	233	296	313	34.3%	5.7%
Others	132	137	101	-23.5%	-26.3%	4	2	0	-100.0%	-100.0%
Total	5,437	5,885	5,588	2.8%	-5.0%	696	801	765	9.9%	-4.5%

Table 3.3: CO2 Emissions and Energy Consumption by energy type fuel in Tokyo
(Source: Tokyo Metropolitan Government, 2010)

4. Methodology

Public policies should be assessed to identify their effectiveness in achieving their stated objectives. In addition, other possible approaches that might be able to achieve similar goals should be identified. This thesis focuses on two climate initiatives and the renewable strategy set by Tokyo Metropolitan Government. By analysing each policy's driving forces and barriers, the key factors that are likely to realise the policy objectives, or lead to difficulties will be identified.

4.1 Document Analysis

Most of the basic information regarding Tokyo's climate change strategy was collected from the official website of Tokyo Metropolitan Government. This is a first logical step to identify key policies and strategies set by TMG.

The documents that will be analysed are listed below. However, there were no up-to-date documents available on either the website or the office. Therefore, it was difficult to find the latest data, especially data generated after the Great East Earthquake of 2011.

- Tokyo Climate Change Strategy (TMG CCS 2007)
- Tokyo Climate Change Strategy Progress Report (TMG PR 2010)
- Tokyo's Climate Change Measures (TMG CCM 2007)
- On the path to a low carbon city (TMG LCC 2011)
- Tokyo Renewable Energy Strategy (TMG RES 2006)
- Stakeholder meeting report (TMG SMR 2007, 2008)
- Tokyo Metropolitan Environmental Mater Plan (TMG EMP 2008)

4.2 In-depth Interview

In order to collect realistic data, an in-depth interview is necessary. Several hypotheses and detailed questions will be developed, and then interviews will be conducted with several key actors and stakeholders relating to climate change and energy issues in Japan and within the Tokyo Metropolitan Government. This process can help understand real situations and obtain the latest primary information, since policy documents do not always provide detailed, realistic data.

Most interviews lasted for approximately one hour. Climate change and energy issues are currently very sensitive topics in Japan, thus most interviewees were not willing to allow the interview to be recorded. However, most interviewees were willing to provide internal specific documents as well as official information. Also, they permitted the interviewer to take notes. Therefore, a great deal of documents and brochures could significantly support the analysis of the results of these interviews recorded as notes and transcripts.

Actor

Organization	Interviewee	Position/Department
METI	METI 1	Chief Negotiator of COP15 for Japan
TMG	TMG 1	Planning official, Environmental Dep.
	TMG 2	Energy Efficiency official , Environmental Dep.
	TMG 3	Renewable Energy official, Environmental Dep.
Kyoto University	KYOTO 1	Professor, Chair of FIT committee of METI
Chiyoda-ku	Chiyoda 1	Official, Planning Dep.

Table 4.1: Interviewees' List for Actors (2012)

Stakeholder

Keidanren	Keidanren 1	Official, Environmental Dep.
Japan Business Federation	JBF 1	Official, Environmental Dep.
Tokyo Chamber of Commerce and Industry	TCCI 1	Official, Environmental Dep.
Tokyo Electric Power Company	TEPCO 1	Operator (Public Information)
Japan Council for Renewable Energy	JCRE 1	Official, Environmental Dep.
Tokyo Building Owners and Management Association	TBOMA 1	Official

Table 4.2: Interviewees' List for Stakeholders (2012)

5. Case Background

5.1 Tokyo's Climate Change Strategy Policy Measures

As CO2 emissions trends in the commercial and residential sectors increase, TMG has launched specific policy measures to reduce CO2 emissions in large facilities and office building sectors (TMG 2010). This paper investigates two major initiatives; namely, the Tokyo Cap and Trade Program and the Tokyo Green Building Program.

5.1.1 Tokyo Cap and Trade Program

TMG set a cap at the city level on emissions from large commercial and industrial buildings. This program focuses on mainly demand-side management. Since the implementation, there is high expectation on its effectiveness as a measure set by local government (Nishida and Hua 2011).

This program was planned to target existing buildings that consumes large amounts of energy. Thus the program covers about 1,300 large–scale facilities that emit 40 per cent of all CO2 emissions in the commercial and industrial sectors. The total cap on the targeted sector is six per cent below base-year for the first five years (2010-2014). In the second stage, these facilities will be expected to reduce their emissions 17 per cent below base-year emissions.

The responsibility for emissions reduction falls onto building owners, with whom tenants are required to cooperate with the building owners to achieve reduction targets and report the progress. Building owners who fail to meet the reduction targets are fined as much as US$600 and surcharged a maximum of 1.3 times the cost of unfilled reductions (Nishida and Hua 2011).

This scheme allows business owners to choose the most cost effective methods of reducing emissions, including emission trading. For instance, this program introduced three types of emission offsets such as emission reduction from small and medium size facilities, renewable energy credits, and emission reduction outside of Tokyo (TMG 2007). While CO2 emission mitigation is the main goal of Japan's Cap and Trade Program, it may have a beneficial effect on creating new markets for green products and technologies (Nishida and Hua, 2011).

Another significant feature is that, in TMG's program, the carbon market is organized as semi-closed and is no linked to other global markets. This mechanism can reduce the risk of market-based trading schemes. Also, this program was designed in a simple way that targets only energy-based CO2 emissions with clear data sources that exist for CO2 inventory calculation. Such simplicity helped stakeholders to understand the programme.

In TMG's Cap and Trade Program, consensus building was a significantly important key factor to motivate and engage stakeholders. After announcing the program in 2007, TMG collected opinions from business sectors, NGOs, academics and other main stakeholders (Nishida and Hua, 2011). The key system for building effective consensus consists of expert panels, stakeholder meetings, and forums, seminars, and workshops. In the Japanese policy-making process, these consensus processes featuring a wide range of stakeholders in a public place is rare.

Items	Description
Facilities covered	**1,300 large CO_2-emitting facilities** in the Tokyo area that consume more than 1,500 kiloliters (crude oil equivalent) of energy annually •Individual facilities or buildings are the basic unit of emissions reduction obligations and emissions trading •In principle, responsibility for meeting obligations on facility owners
Gas covered	Energy-related CO_2
Compliance periods	**Two five-year periods (fiscal years)** •First period: 2010 to 2014 •Second period: 2015 to 2019
Emission caps	**6%** reduction below base-year emissions (first compliance period) About **17%** below base-year emissions (second compliance period)
Base-year emissions	Average emissions of three consecutive years between 2002 and 2007
Emission allowance	Base-year emissions × (1-compliance factor*) × 5 years * **6%** for factories, **8%** for office buildings and other facilities
Emission trading	Excess reductions (beyond compliance factor) are tradable after second year
Offsets (credits)	**Three types of offset credits** are currently permitted •Emission reductions from small and midsize facilities in Tokyo •Renewable energy credits •Emission reductions outside Tokyo area
Reporting, verification	Verified reporting is required every year based on TMG guidelines Verification agencies are registered by TMG governor.
Banking, borrowing	Banking to the second commitment period is permitted. Borrowing is not permitted.
Tenant obligations	Tenants are required to cooperate with emission reduction measures taken by building owners. Specified tenants using a large floor area or a large amount of electricity are required to submit their own emission reduction plans to TMG via the building owner, and to implement the plans.
Penalties	Fines, charges (up to 1.3 times the shortfall). Violation will be published.

Table 5.1: Tokyo Cap and Trade Program

(Source: On the Path to a Low Carbon City: Tokyo Metropolitan Government, 2010)

5.1.2 Tokyo Green Building Program

Every new construction a large building (over 5,000 square meters in total floor area) in the Tokyo region is required to employ environmentally friendly design principles. Under this program, more than 1,500 buildings have disclosed their 'Green Specs' since 2002. Through this rating and reporting system, the Tokyo Green Building Program aims to create a greener building market in which energy-efficient and environmental buildings can be more valued than less-green buildings. The most recent revisions to the programme added the requirement of a feasibility study for the use of renewable energy devices on site (TMG PR 2010).

In the Tokyo Green Building Program, environmental performance is evaluated by twelve items in the four categories (see Table 5.2). Each item will be described as part of a three grade rating system (TMG PR 2010). After addressing the Tokyo Green Building Program in 2002, all large-scale buildings have been assessed for environmental performance, then the results are published on the city's website.

Items	Description	
Facilities covered	Newly planed large buildings over 5,000 square meters in total floor area	
Items assessed	Categories	Items
	Energy	Building thermal load (insulation) Renewable energy devices (on-site renewables) Energy-efficiency systems (building equipments) Building energy management systems
	Resources, materials	Use of eco-friendly materials, ban on the use of fluorocarbons, longer building life, water recycling
	Natural environment	Greening, landscaping, bio-diversity, water conservation
	Heat-island effect	Heat emissions, ground surface cover, wind environment
Rating	Each item is rated using three rating grades (1-3)	
Reporting, disclosure	Environmental plan and rating results must be reported before applying for a building permit. Ratings are displayed with charts on TMG website.	

Table 5.2: Tokyo Green Building Program

(Source: On the Path to a Low Carbon City: Tokyo Metropolitan Government, 2010)

6 Finding and Analysis

6.1-Introduction

TMG focuses on two principles for climate change mitigation measures. The one is energy efficiency measures and the other is deployment of renewable energy. To realise these principles, the Tokyo Cap and Trade Program and the Tokyo Green Building Program have had remarkable effects in the Tokyo context (TMG CCS 2010). These policies can create a positive linkage between regulation, planning policy, and the development of market mechanisms. The alliance between CO2 reduction programs and green infrastructure deployment may have a positive multiplier effect. Furthermore, a wide range of stakeholders such as NGOs, industry representatives, experts, and citizens have participated actively and played an important role in the policy-making process and implementation phase (TMG CCS 2007). This may lead to a significant change in institutional patterns and the creation of innovative market mechanisms for deployment of low-carbon and energy efficiency infrastructures in the Tokyo context.

6.2 Analysis of the Tokyo Cap and Trade Program

TMG implemented its cap-and-trade program in 2010. After 2010, affected building owners have legal obligations to reduce their CO2 emissions by a certain amount. Most new, large facilities are energy efficient and are utilising as many green technologies as they can afford. Also, a number of old facilities have been renovated to be energy efficient under this policy (TMG PR 2010).

The strengths, weaknesses, opportunities, and threats (SWOT) relating to this policy will be identified through the use of document analysis and in-depth interview data.

6.2.1 Strengths

In terms of energy efficiency measures, Tokyo's Cap and Trade Program has directly contributed to efforts to reduce CO2 emissions and improve energy efficiency in large office building sectors. This has also succeeded in enhancing building owners' awareness of their need to reduce CO2 emissions. Tokyo Cap and Trade Program targets only energy-based CO2, thus energy efficiency measures were identified as much easier to understand for building owners than CO2 emissions measures because they can track them by checking their energy bills, and energy efficiency measures can directly contribute to cost efficiency itself; thus, building owners are willing to improve energy efficiency measures for their facilities (TMG interviewee 2 2012).

6.2.2 Weaknesses

As for CO2 emissions measures, however, it can be seen that it is still difficult to motivate building owners and tenants to make efforts to reduce CO2 emissions unless they can obtain benefits by reducing CO2 emissions or pay a penalty for not doing so. Thus, Tokyo's Cap and Trade Program can encourage building owners to meet its requirements as a strict obligation. However, there has been enormous discussion relating to the equity issue with this scheme. Specifically, it has been argued that there are no practical common indicators to identify precise energy efficiency measures for different specifications of buildings which were built in different periods and have different functions (Keidanren interviewee 2012, TBOMA interviewee 2012).

6.2.3 Opportunities

The program allows building owners to use three types of offset options – buying credits from small and medium size facilities owners, adopting renewable energy, and reducing emissions outside of Tokyo – which brings multiple benefits for green technology deployment by creating new markets (TMG interviewee 1 2012).

The available offset options also lead to positive linkages with the energy efficiency measures achieved by small and medium facilities, as well as the expansion of green technologies. TMG has promoted energy efficiency measures for small and medium office facilities, and the housing sector, not as an obligation but as a voluntary action. Currently TMG has raised awareness heavily in this sector, because approximately 50 per cent of CO2 emissions from the commercial and industrial sector were generated by medium and small facilities (TMG interviewee 2 2012).

6.2.4 Threats

The threat in Tokyo's Cap and Trade Program is that carbon is not a visible product. Therefore, it might be difficult to control in a limited region, making an international framework essential. However, organising the futures market to include carbon, thus enabling it to be given the same value as other commodities, might threaten the world market trading system. This point was emphasised by most of the interviewed business-sector stakeholders.

6.3 Analysis of Tokyo's Green Building Program

Energy efficiency measure is one of the big pillars of Tokyo climate change strategy. Japan has already proved its high energy efficiency in transport and building sectors comparing to other developed countries. To achieve climate change mitigation target, Tokyo has still much potential to upgrade their assets to be more energy efficient (TMG interviewee 1 2012).

6.3.1 Strengths

The CO2 and energy efficiency reporting system established in the office building and housing sector under the Tokyo Green Building Program has significantly raised people's awareness of energy efficiency measures. The system is a very practical way to show people how much energy they have consumed and how it influences their energy bills. As long as it is impossible to regulate medium and small businesses, promoting behavioural change may significantly reduce the total amount of CO2 emissions and inefficient facilities. TMG interviewee 2 (2012) emphasised it becomes obvious to people that they can change their ordinary behaviours, or at least make an effort to do so, when they recognise their energy bills can be dramatically reduced.

6.3.2 Weaknesses

Little information has been provided to building owners to employ energy-efficiency equipment and latest green technologies for their buildings. Moreover, TMG has not prepared enough subsidies for building owners to upgrade the facilities. (TMG interviewee 1 2012) In addition, CO2 emissions in building scale heavily rely on the energy use of tenants, however, this policy focuses on only building owners, that is not practically effective to reduce overall energy demand in a city (TMG interviewee 2 2012).

6.3.3 Opportunities

After the Great East Japan Earthquake, people had to immediately change their behaviour relating to energy use due to significant energy shortages. It was an unprecedented situation that required strict measures; however, people in affected regions clearly demonstrated that it is possible to significantly reduce one's energy demand by changing one's daily behaviours (TMG interviewee 2 2012). An interviewee with TEPCO stated that there is an effective plan to provide smart meters to every household in the country, which will be subsidised by the central government in the near future. He also explained the importance of demand-side management to reduce the total amount of energy demand and CO2 emissions on the basis of the hard experience gained in the aftermath of the earthquake. This demand-side management, such as human behavioural changes, can significantly influence environmental performance under the Tokyo Green Building Program.

6.3.4 Threats

This policy covers only large-scale buildings over 5,000 square meters, however, 50 per cent of CO2 emissions are still emitted by small and medium size buildings that are very difficult to regulate and control through policy due to the complexity of grasping real facility data that is spread throughout the urban scale, in industrial and commercial sector in Tokyo (TMG interviewee 2 2012).

7. Conclusions

7.1. Introduction

Two key events have highlighted the need for fundamental social structural changes in Japan. Firstly, climate change is one of the greatest concerns on a global scale, including in Japan. A new global and national framework for tacking climate change issues is essential; moreover, cities' action plans can contribute considerably to reducing environmental risks in the short and long term. Tokyo's climate change strategy is one of the progressive examples of how an area can set its own targets for CO2 reductions and energy efficiency measures.

Secondly, the other significant event was the Great East Japan Earthquake in March 2011. After this event, Japan required physical and social mechanism changes due to massive energy issues caused by nuclear power accidents and successive energy security problems. Specifically, Tokyo had sourced most of its energy from nuclear reactors in the Tohoku region that were destroyed in the earthquake. The earthquake showed that megacities that with centralised energy systems that rely on energy supply that comes from outside their cities must reconsider their future energy systems.

7.2 Key Findings across the Two Initiatives

In terms of energy efficiency measures, Tokyo's Cap and Trade Program has significantly contributed to raise citizens' awareness and provided a number of energy efficiency measures for existing large facilities in Tokyo. Upgrading facilities may lead to the creation of an effective green technology market. TMG has attempted to enhance these new market mechanisms to deploy green innovations, thus creating an effective free market. Tokyo's Green Building Program has also succeeded in providing realistic visible data regarding energy efficiency measures by using a rating report system. Both the Tokyo Cap and Trade Program and the Tokyo Green Building Program can encourage renewable energy use for offsetting carbon credits and enhancing energy self-sufficiency.

The expansion of renewable energy production, on the other hand, comes with limitations for installing solar PV on the roofs of buildings, because it is not very cost effective and current solar PV performance has not been proven to produce sufficient energy for megacities such as Tokyo (TMG interviewee 3 2012). However, TMG takes the CO2 credits offset outside Tokyo and renewable energy production into account for creating new social systems to change the existing systems. Specifically, Tokyo's Renewable Energy Strategy requires upgrading the energy network infrastructure on a national scale. This also requires social structural change to realise the shift from the current centralised energy system to a decentralised energy system, including institutional pattern change.

A decentralised energy system might be key to replace the current nuclear and fossil fuel-based energy system with one that is based on renewable energy. However, this change requires enormous contributions from the political system to transform and upgrade existing physical infrastructures. A number of papers; for instance, those listed in the literature review section (3.5), and an interviewees stated that there are few contributions from the planning system to control a practical local master plan; moreover, municipalities have little power to put their own needs into a local master plan. Therefore, significant structural changes to the planning system are also required because renewable energy relies heavily on the local context.

Tokyo' s Cap and Trade Program	Driving Forces	Barriers
Economic Factor	- Semi-closed market (less risky) - Reduce energy related running cost (Energy Bill) - CO2 reporting system with providing subsidies for upgrading facilities.	- Strict obligation for only building owners - Market uncertainty - Lack of effective market for latest green technologies
Political Factor	- Effective consensus buidding (includes expert panel, stakeholders meeting, forums) - Three type of offset options - Raising awareeness	- Equity of setting caps - Lack of gathering feedbacks from stakefolders after implementation - There is possibility for business sectors to escape to outside of Tokyo where not being regulated.
Technical Factor	- Simple coodination as targeting only energy-based CO2 emissions	- There is no practical common indicators to identify precise energy effeiciency measures for differenet specs

Table 7.1: Tokyo Cap and Trade Program Analysis (Driving forces and Barriers)

Tokyo Green Building Program	Driving Forces	Barriers
Economic Factor	- Create greener building market - Energy efficiency is more valued that less greener buildings - Visibility of cost reduction	- Lack of public funds (subsidies) - Lack of effective funding mechanisms with private funds -Lack of effective green market for the latest energy efficiency equipment
Political Factor	- All results are published on the city' s website - Includes new and existing buildings - Raiding awareness - Change human behaviours	- Insufficient political framework which supports centralised energy system - Little contribution of planning policies
Technical Factor	- requirement of feasibility study of renewable energy - Linked to other rating systems (i.e. CASBEE)	- Complexity of grasping real facility data - Inflexibility of energy network infrastructure supporting current centralised energy system

Table 7.2: Tokyo Green Building Program Analysis (Driving forces and Barriers)

References

Alagappan, L., Orans, R. and Woo, C.K. (2011) *What drives renewable energy development?* Energy Policy 39 5099-5104

Arima, J. (2011) *International Offsets –Japanese Perspective–*, Presentation document

Arima, J. (2011) *Tackling Climate Change –Japan's View–*, Presentation document

Arima, J. (2012) *After Durban –Japan's Energy and Climate Change Challenges–*, Presentation document

Arisue, T. and E. Aoki (1970) *The development of Railway Network in the Tokyo region from point of View the Metropolitan Growth, in Japanese Cities: a geographical approach.* Association of Japanese Gepgraphyer. (ed) Tokyo: Association of Japanese Geographers. PP.191-200.

Azar, C. (2005) *Post-Kyoto climate policy targets: costs and competitiveness implications*. Climate Policy. 5:3, 309-328

Banister, D. ed. 1991. *Transport and Urban Development*, UK: E&FN Spon

Bulkeley, H. and Betsill, M. (2003) *Cities and Climate Change: Urban Sustainability and Global Environmental Governance.* New York: Routledge

Bulkeley, H., Castan Broto, V., Hodson, M. (2011) *Cities and Low Carbon Transitions,* Routledge:Oxford

Constable, John (2011) *The Green Mirage*. London:Civitas

Cooper, I., M. Symes, (2009) *Sustainable Urban Development Volume4*, UK:Routledge

Cooper, Rachel., G. Evans and C. Boyko (2009) *Designing Sustainable Cities*, UK: Blackwell Publishing. Ltd.

Finco, A. and Nijkamp, P. (2001) '*Pathways to urban sustainability' Journal of Environmental Policy and Planning* Vol 3 pp 289-302

Fouquet, D. and Johansson, B. (2008) *European renewable energy policy at crossroads – Focus on electricity support mechanisms.* Energy Policy 36 4079-4092

Girardet, H. (1992) *Creating Sustainable Cities.* Green Books, London

Grubb, M. and Neuhoff, K. (2006) *Allocation and competitiveness in the EU emissions trading scheme: policy overview.* Climate policy. 6:1 7-30

Keirstead, J. and N. Schulz, (2010) *London and beyond: Taking a closer look at urban energy policy*, London: Imperial College

Koizumi, H (2011) *Machizukuri and Public Participation*, Japan: Gakugei publisher

Newman, P and Jennings, I (2009) *Cities as Sustainable Ecosystems : Principles and Practices,* Island Press, Washington DC.

Neuhoff, K. (2011) *Climate Policy after Copenhagen : the role of the carbon pricing*. UK:Cambridge Press

Neuhoff, K. (2004) *Large Scale Development of Renewables for Electricity Generation.* Camridge Working Papers 0460

Nishida, Y. and H. Ying (2011) *Motivating stakeholders to deliver change: Tokyo's Cap-and-Trade Program*, Tokyo: Routledge
Mackay, D., (2009) *Sustainable Energy-without the hot air,* England: UIT Cambridge Ltd.

Markandya, A., K. Halsnaes, (2002) *Climate Change & Sustainable Development*, London: Earthcan Publications Ltd.

Marshall, S., ed. 2011. *URBAN CODING AND PLANNING*, Oxfordshire: Routledge

Mass, W., (2010) *Green Dream*, Amsterdam : The Why Factory and NAi Publishers

Moor, S., Ed. (2010) *Pragmatic Sustainability*, USA:Routledge

Neuhoff, K., (2011) *Climate Policy after Copenhagen*, Cambridge University press

Ringel M. (2006) Fostering the use of renewable energies in the European Union: the race between feed-in tariffs and green certificates. Renewable Energy 31 1-17
Rojas, V. A. (2011) *Developing New Financing Mechanisms to Support Energy Efficiency, renewable Energy and Other Climate Change Initiatives(RFP)*, Illiois: City of Chicago

Ryden, Y., (2010) *Governing for Sustainable Urban Development*, UK: Earthcan

Sassen, S., 2006. *CITIES IN A WORLD ECONOMY*, California: Pine Forge Press

Shrimali, G. and Kniefel, J. (2011) Are government policies effective in promoting deployment of renewable electricity resources? Energy Policy 39 4726-4741

Sijm, J.P. M. (2002) The Performance of Feed-in Tariffs to Promote Renewable Electricity European Countries.

Sorensen, A (2002) *The Making of Urban Japan: Cities and Planning from Edo to the 21st century*, London: Routledge

Smith, F. P., 2010. *BUILDING FOR A CLIMATE CHANGE*, London: Earthcan

Smith, Peter., (2010) *Building for a Changing Climate* :UK Earthcan

Tschakert, P. and Olsson, L. (2005) *Post-2012 climate action in the boad framework of sustainable development policies* : the role of the EU. Climate Policy, 5:3, 329-348

Ueta, K. and K. Kajiyama (2011) The New Energy Concept After 3.11, Japan:nikkeibook

Wheeler, S., T. Beatley (2004) *Sustainable Urban Development Reader*, USA: Routledge (The Metabolism of Cities)

Watanabe, C., and Shum, K. (2009) *An innovation management approach for renewable energy deployment-the case of solar photovoltaic (PV) technology.* Energy Policy 37 3535-3544

Williams, J. (2009) *The deployment of decentralised energy systems as part of the housing growth programme in the UK,* Bartlett School of Planning, University College London, UK,

Williams, J. (2011) *ZERO CARBON HOMES* – A ROAD MAP. Earthcan

Wilson, E., J. Piper, (2010) *Spatial Planning and Climate Change*, NY: Routledge

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