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Risky Business: A Micro & Macroeconomic Analysis of Policy Scenarios and Energy Mix Risks

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There are risks and costs to a program of action, but they are far less than the long-range risks and costs of comfortable inaction

- John F. Kennedy

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Hesitation increases in relation to risk in equal proportion to age.
- Ernest Hemingway

INTRODUCTION

Over the past decade, the world has experienced an exponential growth in technology. From increased access to intellectual property and resources, the sharing of knowledge has never been so easy. However, despite this abundance of knowledge, we have managed to submerge ourselves in one of the most precarious situations since the Great Depression of the 1930's. There seems to be an unprecedented amount of problems our generation is facing; global warming, the 2008 Financial Crisis, oil price shocks, cyber hacking, warfare, and nuclear threats, met with a level of denial and inaction by markets and national governments.[1] However, some of these problems have produced tremendous events, such as Hurricane Katrina, the increased requirements by the Basel Accords, and the domino effect of the oil price drop in Venezuela. These events have not only raised awareness, but have also shown the reality to the possibility of worst-case scenarios.

These driving factors of the last ten years have produced the role of Risk Management. As large companies and small businesses alike rely on the stability of cash flow, it is clear that events, both regionally and globally, do not always make this stability plausible. As a fairly new business department, the assimilation of a proper Risk Management Program into business today has sometimes been ironically met with uncertainty and confusion.[2] Nevertheless, an integrated value-based Enterprise Risk Management program (ERM) is capable of distributing inevitable risk exposure over a number of possible events that deviate from the expected result, and can smooth the magnitude of the subsequent outcomes. At a microeconomic level, Board of Directors and shareholders can engage strategically into satisfying compliance and international variations of SEC (Securities and Exchange Commission) disclosure requirements while maximizing returns on

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[1] William Nordhaus, *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World* (Yale University Press, 2013), p. 18.

[2] Sim Segal, *Corporate Value of Enterprise Risk Management: The Next Step in Business Management* (John Wiley & Sons, 2011), p. xvi.

investments.[3] From a macroeconomic level, government bodies will be able to use ERM with respect "to their entities, and how this can better leverage their limited resources and help them achieve their strategic objectives".[4]

Currently, governments and businesses all over the globe have been experiencing a unique moment of inconvenient truth; "economic growth is producing unintended but perilous changes in the climate and earth systems".[5] Since the beginning of the climate debate, developed and developing countries have used this moment, not as an opportunity, but rather to finger-point at who they believe is responsible for the degeneration of our planet; arguments such as the belief that developed countries consume and emit the most energy and greenhouse gas (GHG) per capita, and whether developing countries are on the brink of their very own industrial revolution with the addition of rapidly increasing population. No one country has sought to take real responsibility for their part played, no matter how seemingly insignificant or not. A large factor in this lack of acknowledgement is the fact that many experts, politicians and citizens do not always agree about whether global warming is real, whether it is important, and whether it affects or concerns their own lives.[6] For this reason alone, global warming can be considered a controversial topic, adding to its complexity over governance. Nevertheless, climate change and global warming is a very real matter, proven through extensive amounts of research from basic climate science, ecology, engineering, economics, politics, and international relations.[7]

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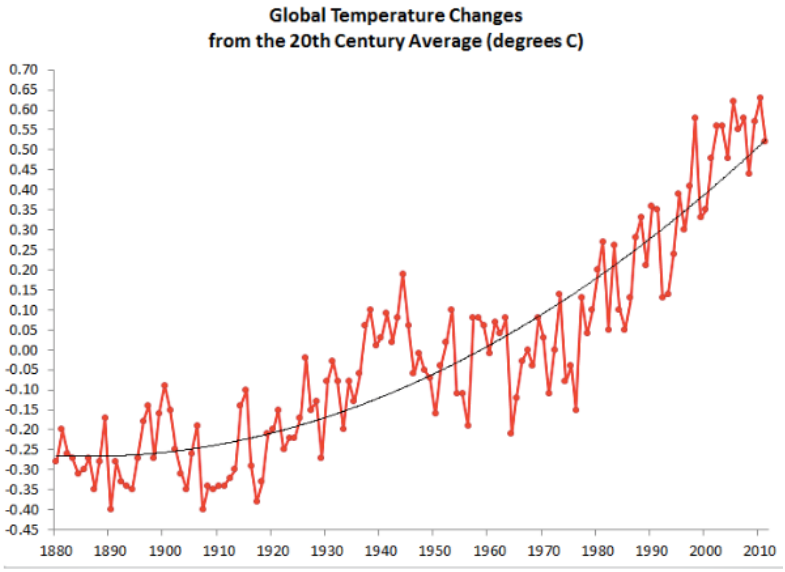
[3] Ibid., pp. xiv-xv.

[4] Ibid., p. xv.

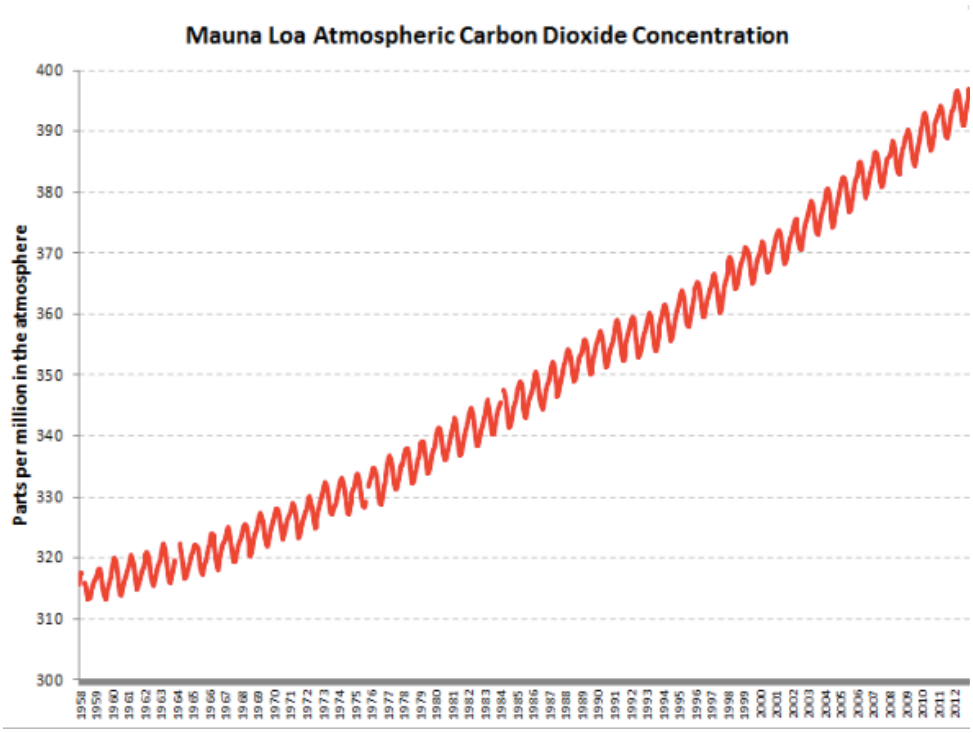
[5] Nordhaus, *The Climate Casino*, p. 3.

[6] Ibid., p. 3.

[7] Ibid., p. 4.



(**Source**: Huffington Post, "Oh Wait: The Earth Really Is Warming. Fast.," http://www.huffingtonpost.com/peter-h-gleick/oh-wait-the-earth-really_b_3003216.html, accessed March 2015.)



(**Source**: Huffington Post, "Oh Wait: The Earth Really Is Warming. Fast.," http://www.huffingtonpost.com/peter-h-gleick/oh-wait-the-earth-really_b_3003216.html, accessed March 2015.)

It is no mystery that the primary source of global warming is the burning of carbon-based, fossil fuels such as coal, oil, and natural gas, leading to the combustion and production of emissions of carbon dioxide (CO2). The production of these emissions, or GHGs, originate from our personal

lives; from driving children to school, to powering the refrigerator in our homes, to switching on the television. According to an Environmental Design course led by Patrick Condon at the University of British Columbia, 40% of GHGs in Canada result from direct (combustion of gas and diesel from vehicles) and indirect transportation (chemicals, cement production, production of iron and steel, fossil fuel extraction, etc). The remaining 60% result from buildings' emissions, including the things we place inside of them (lights, computers, microwaves, etc).[8] However, GHGs are also emitted at operational levels in businesses, government development, and trade. The subsequent consequences, from a personal to a national level, include impacts we are currently aware of and can feel today, such as unusual dips or spikes in temperature, intensity of storms, ice cap melting, and extended droughts. Severe impacts are "likely to be most heavily concentrated in low-income and tropical regions such as tropical Africa, Latin America, coastal states, and the Indian subcontinent."[9]

Methane is the second, most widespread source of GHGs. It originates from natural sources such as livestock and wetlands, and normally is removed by natural, chemical processes in the atmosphere. When emitted, methane is 25 times more powerful than CO2 emissions per pound, but has a significantly shorter lifetime in the atmospheric layers than CO2.[10] Due to the differences in origins of these two powerful greenhouse gases, one from energy and one from natural sources, there is a direct focus on energy related GHGs, or CO2. However, it will be important to later consider the risk of significant mass-release of methane from melting ice sheets in the Arctic.

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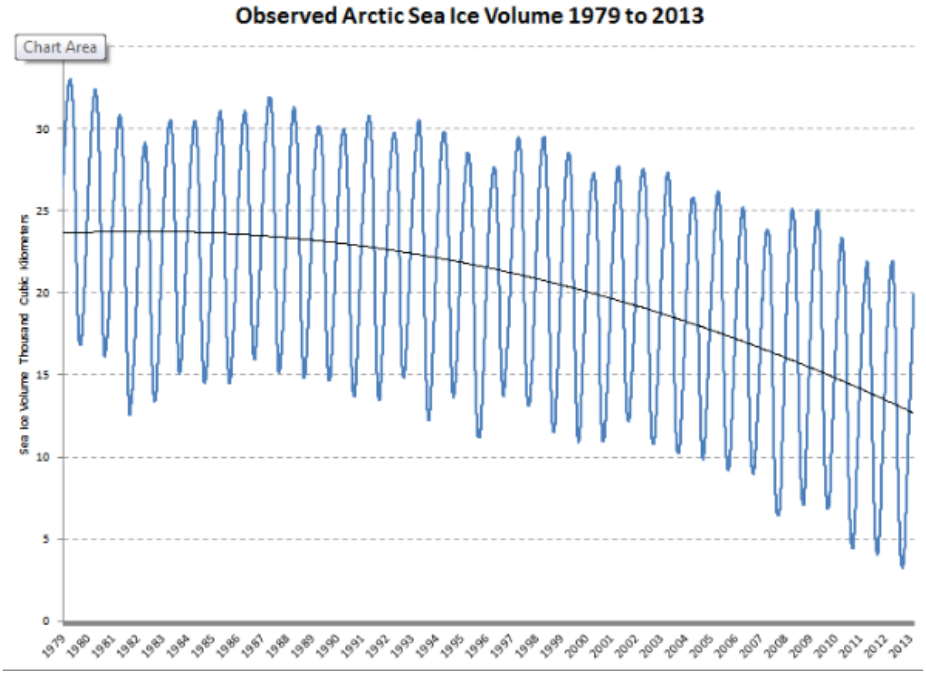
[8] Patrick Condon, "Lecture 1: Introduction," Environmental Design, Spring 2013, University of British Columbia, Vancouver, Canada, [https://docs.google.com/file/d/0B0WWDAVvOPcoMWZNa1F1cFpZUEU/edit], accessed March 2015.

[9] Nordhaus, *The Climate Casino*, p. 5.

[10] United States Environmental Protection Agency, "Overview of Greenhouse Gases," http://epa.gov/climatechange/ghgemissions/gases/ch4.html, accessed January 2015.



(**Source**: Huffington Post, "Oh Wait: The Earth Really Is Warming. Fast.," http://www.huffingtonpost.com/peter-h-gleick/oh-wait-the-earth-really_b_3003216.html, accessed March 2015.)

Thus, the following questions remain: How at risk is our planet? Are we responsible for the fate of our own country? Could we slow the effects of global warming ourselves? And what could governments do to cease these impacts caused by global climate change? The answer is quite straightforward: cooperation. Regrettably, the reality is not so straightforward. Global warming is a particularly difficult issue to solve with cooperative policy for the simple fact that global warming affects the entire globe, but costs are regionally incurred. Furthermore, the affects accumulate over many, many years and far into the future. Environmental experts and political advocates for climate policy have attempted to quantify and estimate the potential damages of global warming, but the reality is that policies affect both the micro and macroeconomy, which can be quite costly to implement. For developed countries, such as Canada, whose Gross Domestic Product (GDP) heavily relies on its carbon-based resources, participation in international climate compliance policies do not seem very encouraging. For developing countries, such as China, whose economy is in the midst of industrialization and rapid growth, climate policies are not convenient.

The first attempt at creating an international climate policy was the United Nations Framework Convention on Climate Change's (UNFCCC) Kyoto Protocol. The Kyoto Protocol was incredibly successful in spurring an international debate on global warming and the resulting actions that should or should not be taken by ratifying countries. Unfortunately, the Kyoto Protocol was also incredibly unsuccessful in providing adequate incentives to encourage countries to participate and ratify the treaty, and had set unrealistic targets. The controlling and reduction of emissions is a regional responsibility, and while many countries, such as Japan, found this treaty as an opportunity to produce new, technologically renewable energy sources into their economy, many other countries found this as an opportunity to free-ride on the beneficial effects of emission reduction without having to lift a finger.

Fortunately, over many years of process improvements and huge advancements in energy technology, there is a great foundation for emission reduction. Due to these technological advancements, some of the fastest growing economic sectors, such as electronics and health care, require much less energy per output than they used to.[11] Thus, there exists a global decline of carbon intensity called decarbonization; CO2 emissions have not been growing as rapidly as world output.[12] Despite this, as stated in the International Energy Agency's (IEA) 2014 Executive Summary, "the point of departure for the climate negotiations, due to reach climax in 2015, is not encouraging: [there exists] a continued rise in global greenhouse-gas emissions and stifling air pollution in many of the world's fast-growing cities."[13] Thus, even with the existence of decarbonization, global energy demand is growing, particularly in emerging economies, which

[11] Nordhaus, *The Climate Casino*, p. 22.

[12] Ibid., p. 22.

[13] International Energy Agency, "World Energy Outlook 2014 Executive Summary" (PDF file), downloaded from IEA website, [https://www.iea.org/Textbase/npsum/WEO2014SUM.pdf], accessed 20 February, 2015.

results in a global growth of CO2 concentrations. This phenomenon is called Jevon's Paradox, a result of producing less carbon intensive energy and offsetting this improvement in production with out-of-the ordinary, additional consumption.[14] By lowering the intensity of the effects of carbon-producing fuels, populations adopt the mentality that, at a personal level, if it is less harmful now to, say, fill up a tank of gas than it was 20 years ago, then they will fill up their tank of gas twice as much. This is not that affecting at an individual level. The problem arises when everyone adopts this mentality and world population of seven billion people end up filling up their tank of gas twice as much, completely negating the positive effects of less-carbon emitting technology.

In the short-run, approximately 50 to 70 years, renewable technology would cost far more to replace existing infrastructure than if countries continued the use of non-renewables. Renewable energies would require new power plants, new factories, different engines and furnaces,[15] creating exceptionally high switching costs. However, high-carbon products are not currently priced to include the negative environmental impacts caused. If priced, the marginal cost of continued production and consumption of high-carbon products would be far greater than the marginal cost of implementation, production, and consumption of low-carbon energy products. In the long-run, approximately 150 years, low-carbon energy switching costs would actually pay off. Policy makers have a very difficult argument to make in order to convince government officials and shareholders of businesses to implement low-carbon energy infrastructure when the vast majority of the world's population today will not see the final effects of the policy they sign and ratify. If there is no political interference, or even an attempt at creating a climate policy, the risks associated with the current trends in energy production and consumption will be severe and widespread.

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[14] Kenneth P. Green, "The Paradox of Efficiency," American Enterprise Institute, March 11, 2014, [http://www.aei.org/publication/the-paradox-of-efficiency/], accessed June 2015.

[15] Nordhaus, *The Climate Casino*, p. 20.

In a nutshell, countries—specifically emerging economies—are growing expeditiously, and despite the increase in efficiency of energy use, the use of carbon-based resources vastly outranks the use of renewable energy sources. Therefore, the rate of improvement is insufficient to reduce global emissions. In order to be effective, carbon-pricing policies that can reduce and smooth risk exposure from this rapid growth in emissions must be adopted by every single country that emits CO2. Ideally, international policy makers could make a huge difference in the rate of improvement and the adoption of these low-carbon sources. If policymakers are able to create encouraging policies that, at the microeconomic level, greatly benefit businesses who act proactively and penalize those who do not, there will be incentives to act environmentally responsible. In turn, at the macroeconomic level, if governments can approach climate policies without sole concern over hindering national revenues, governments may be surprised at the amount of costs saved in the long run. Internationally, countries can then be more inclined to cooperate on further carbon-limiting mechanisms to reach sustainable temperature increases and emissions targets, considerably reducing the risks the world would face if this level of cohesion was otherwise unachievable.

This research will discuss emission risks within developed and developing economies, specifically in regards to trends in non-renewable and renewable energy sources. These energy risks, corresponding to the much-debated climate policy scenarios presented by the IEA, will showcase the relevant, short-term risks—what we may experience in the next 50 to 70 years—and the long-term risks—what we may experience in the next 150 years and beyond. Using the basis of microeconomic and macroeconomic rational decision-making, the use of ERM as a unique tool, whose application is not limited to businesses, must extend through a bottom-up approach into government management and international policy, if policymakers wish to encourage ratification of future climate treaties.

Living at risk is jumping off the cliff and building your wings on the way down.
- Ray Bradbury

RESEARCH CHAPTERS

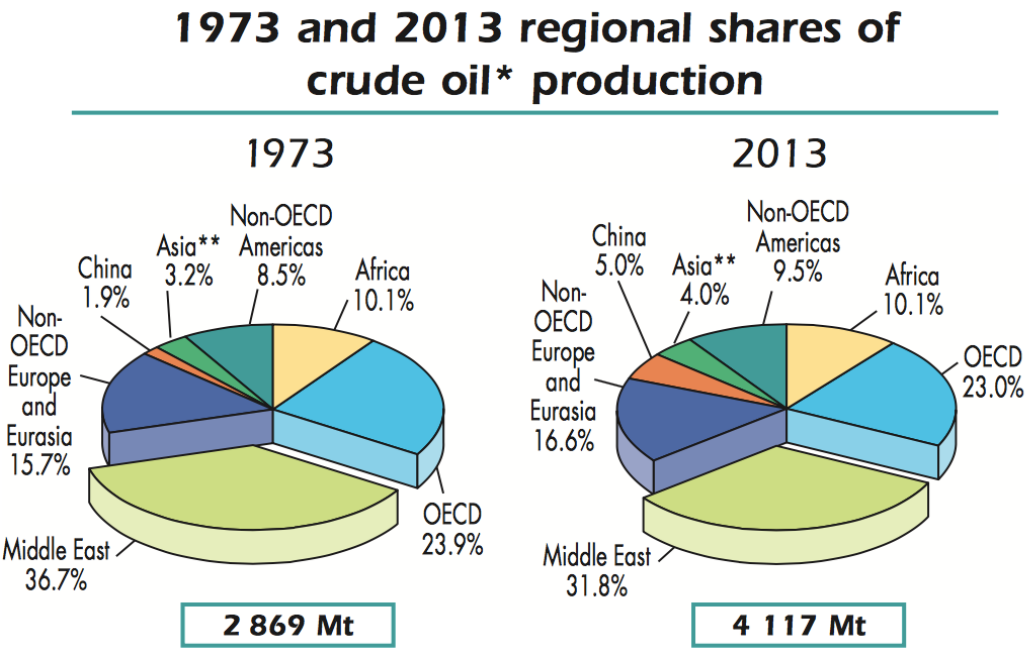
CURRENT TRENDS

In order to properly outlay the global energy mix, trends from 1971 to 2013 have been collected and amalgamated by the IEA in their IEA World Energy Outlook, Key World Energy Statistics 2014. These statistics are a free, 2014 publication from the IEA website. This section, 'CURRENT TRENDS,' nearly exclusively draws upon the IEA's collection of energy graphs, unless otherwise stated, and will be the groundwork for the scenarios and conclusions drawn. Within the key statistics and graphs shown below, Asia refers to all Asian countries, excluding China, and OECD countries refer to those nations who originally signed and ratified the Convention on the Organization of Economic Cooperation and Development. Such countries include but are not limited to Australia, Belgium, Canada, Germany, Greece, Italy, Japan, Norway, Switzerland, the United Kingdom, and the United States of America.

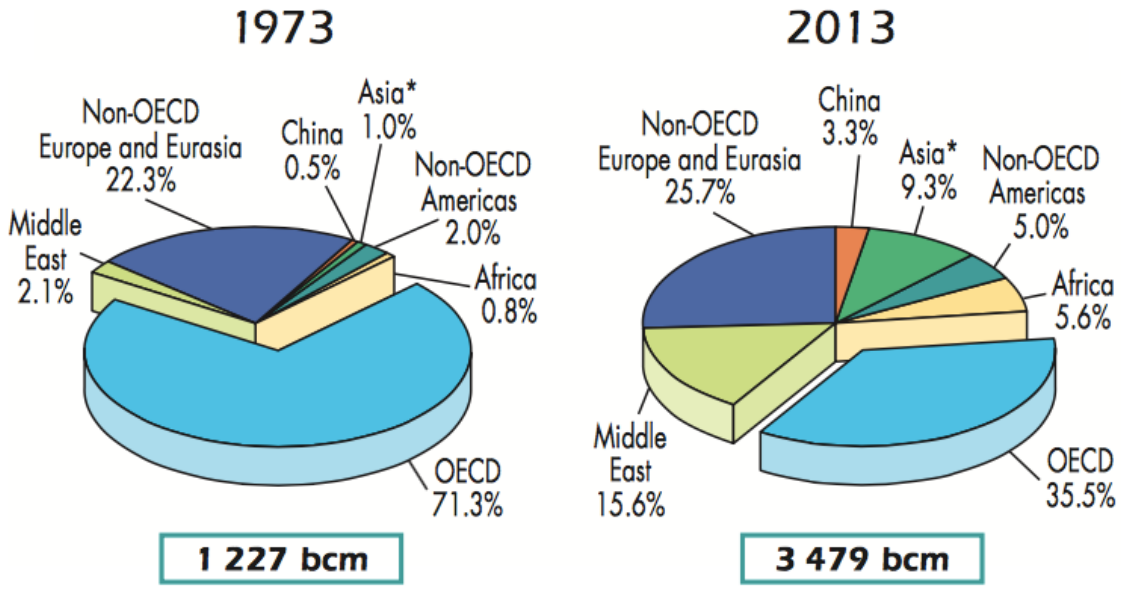
Production of Non-Renewables

Non-renewable energy sources are natural resources that are considered to have a decreasing resource stock with respect to its rate of exploitation.[16] Such resources include oil, natural gas, and coal. Predominantly used for transport around the world, the Middle East has unsurprisingly been the largest producer in oil. Between 1973 and 2013, China's increase in crude oil production share from 1.9% to 5% offset the Middle East's drop in production share.

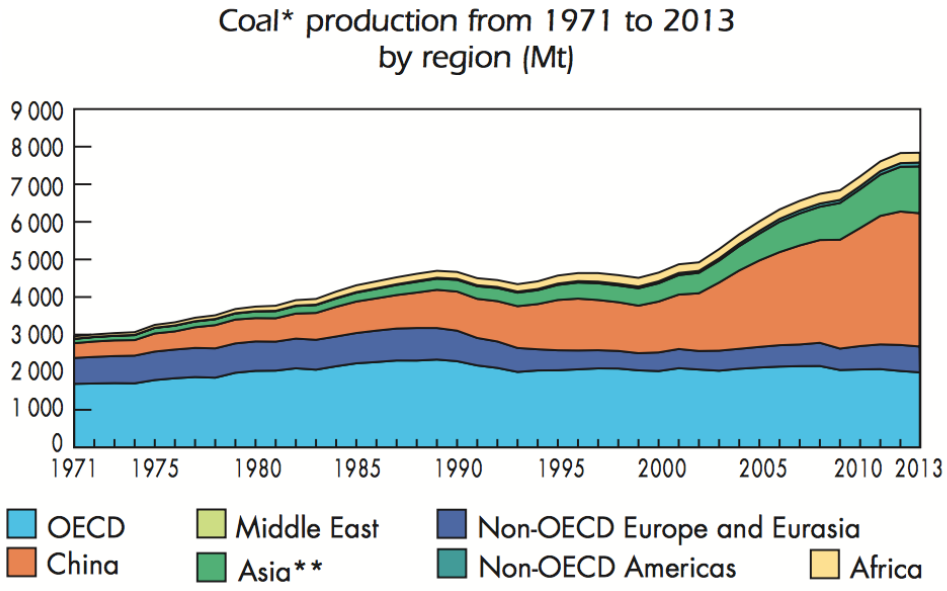
[16] Simone Mori, "Lecture 3: Natural Resources." Economics and Management of Energy Business, Fall 2014, LUISS Guido Carli University, Rome, Italy, [http://docenti.luiss.it/mori/files/2014/09/3-Natural-resources.pdf], accessed March 17, 2015.

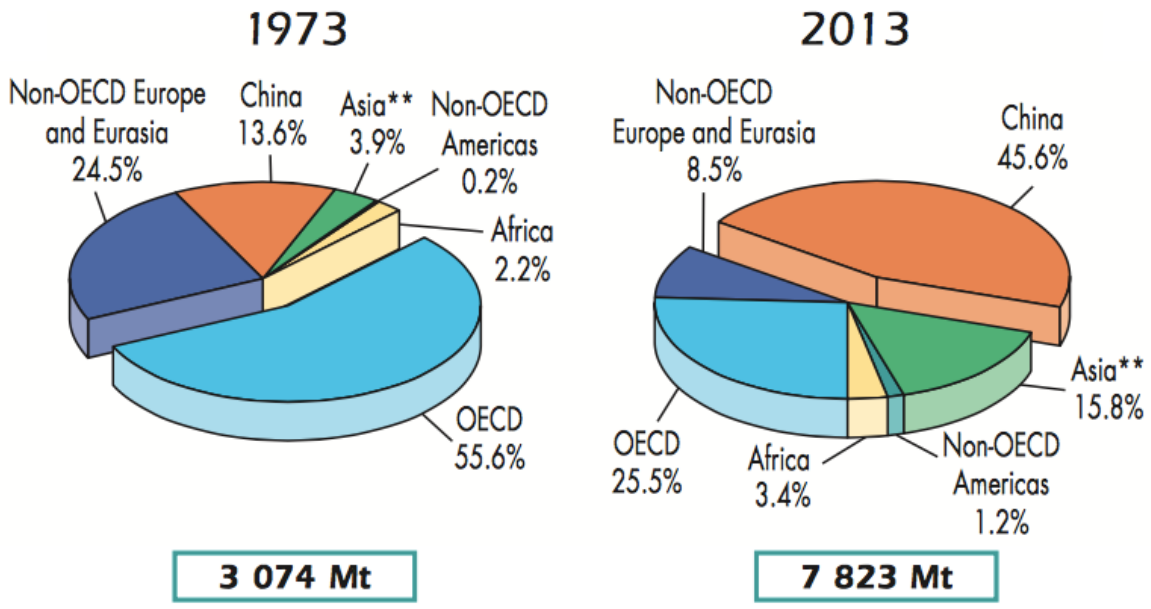


Internationally, natural gas has seen a warm welcome. Used primarily for non-energy use, agriculture, commercial, residential, and public services, natural gas saw a decrease in use in industry over the 1973 to 2013 period. While OECD countries maintained stable production of natural gas, their production share decreased dramatically due to emerging markets' surge in production share; the Middle East increased from 2.1% to 15.6%, Asia (excluding China) increased from 1% to 9.3%, and Africa's share increased from 0.8% to 5.6%.



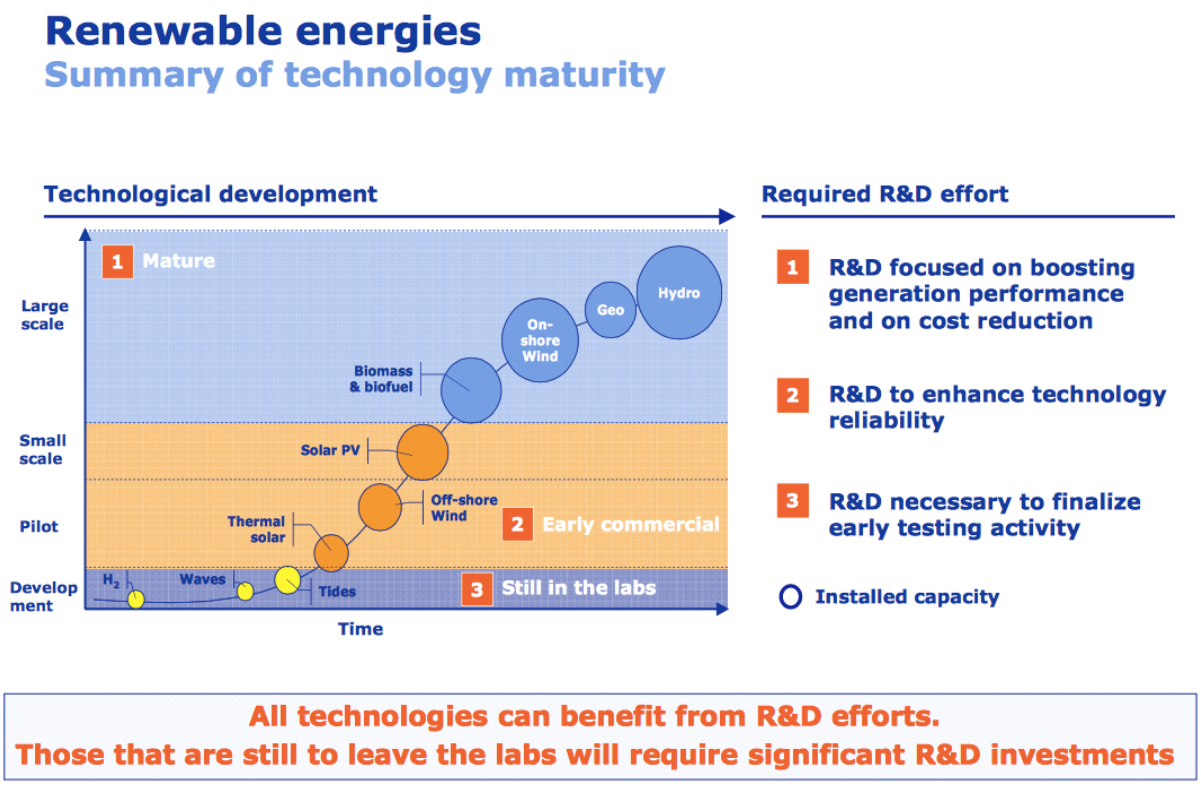
Coal has seen a massive influx of use in China and Asia. Due to the magnitude of China and Asia's economic growth, specifically in industry, coal is preferred in these regions for its cheap prices. China has a noticeably large increase in production and share of production. From 13.6% to 45.6%, China experienced the largest increase in share of production of coal, with the rest of Asia not far behind, with an increase from 3.9% to 15.8%. OECD countries dropped nearly half in production share, dropping from 55.6% to 25.5%.





Production of Renewables

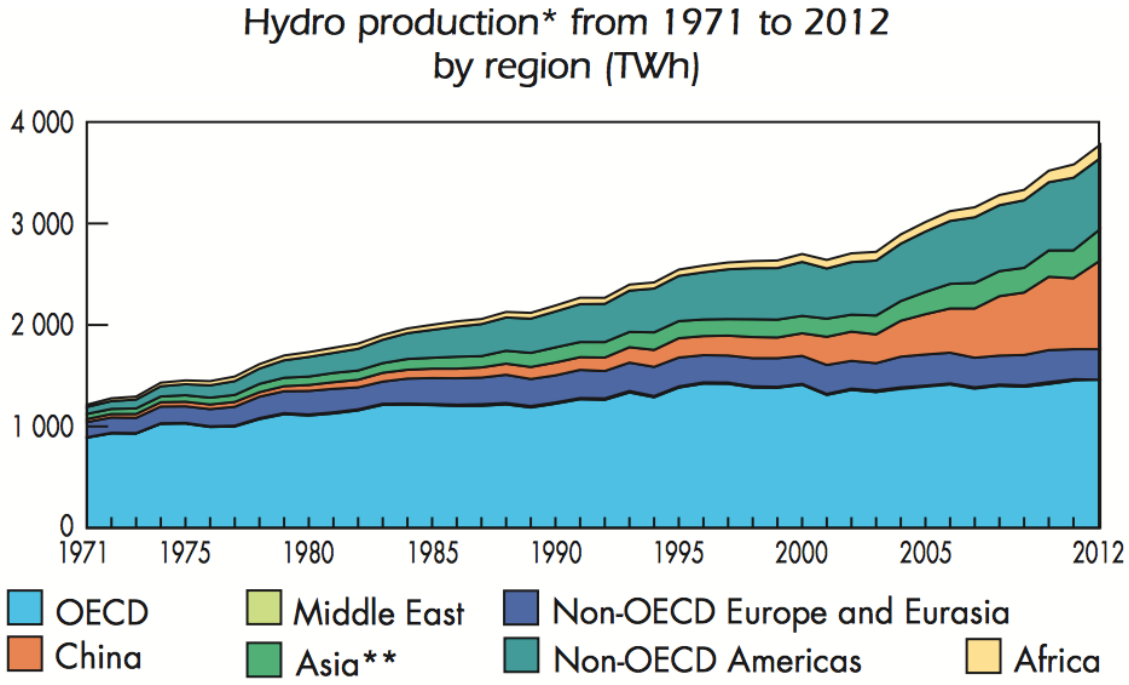
Renewable energy sources are natural resources that are considered to be able to have an increasing resource stock with respect to its rate of exploitation, but cannot increase to exceed the carrying capacity of the ecosystem. Some renewables have continuous cycles, such as solar power or tidal energy.[17] Other renewable resources include wind, biomass, nuclear, and hydro power. Unlike carbon-based fuels, the technological development of renewable resources vary greatly from early development stages to large scale, mature markets.



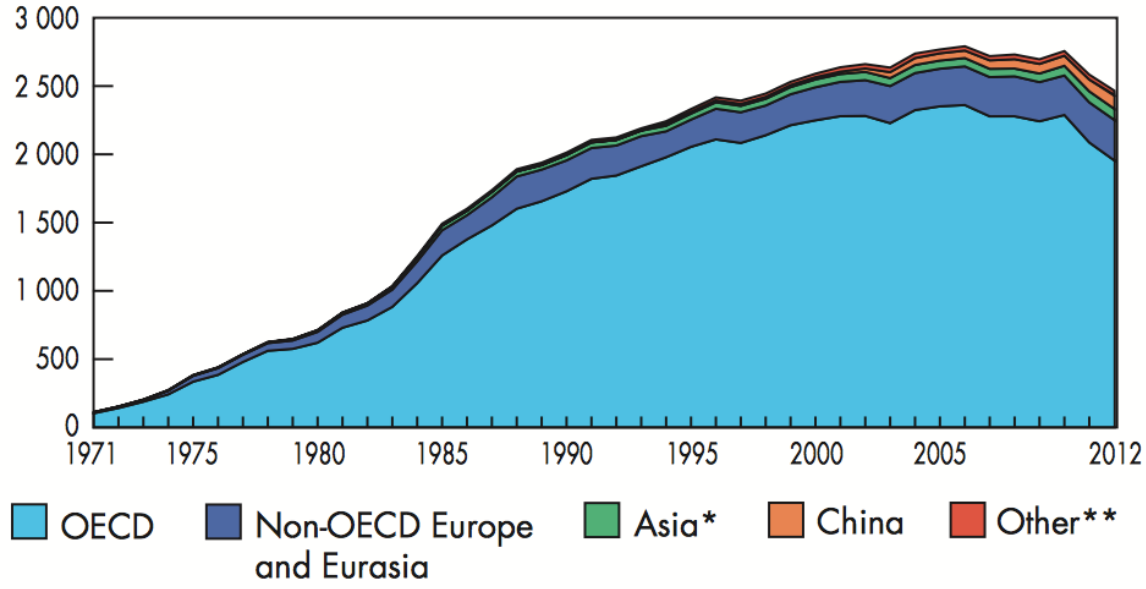
(**Source**: Simone Mori, "Lecture 13: The Green Shift - Renewable Energy Sources." http://docenti.luiss.it/mori/files/2014/09/13.-THE-GREEN-SHIFT-RENEWABLE-ENERGY-SOURCES.pdf, accessed March 2015.)

[17] Ibid.

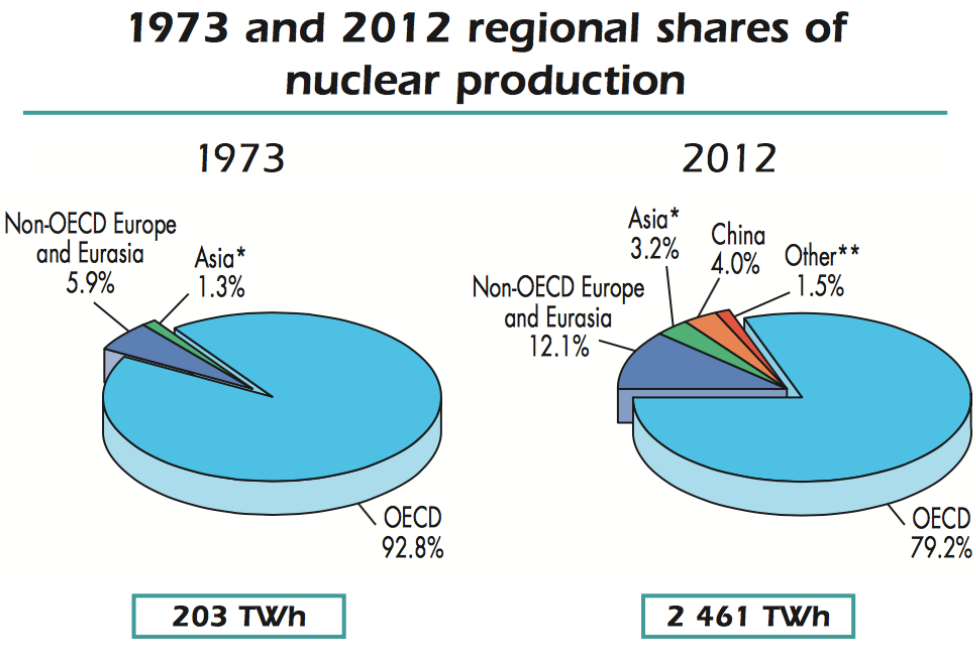
For example, hydrogen and wave-producing energy are still in the very early stages of development and testing, or also referred to as “Still in the labs.” Other energy sources such as off-shore wind and photovoltaic energy are in the first stages of use, and are even placed on a few markets, adopted by those who are willing to pay the current extra cost to test out the technologies, while understanding there may be bug fixes before the technology is virtually fool-proof. Other sources such as geothermal, wind, and hydro power are renewable energy sources that have been on the market for quite some time now, and whose technologies are adopted and differentiated depending on the company. As hydro power is one of the most sophisticated in renewable energy development, hydro power is mature enough to meet constructive criticism over the efficiency of the technology due to its interference with natural ecosystems. However, it is a long proven low-carbon technology, which is why there is no surprise that from 2005 to 2013, China and non-OECD Americas have grown their hydro production share from 2.9% to 23.2%, and 6.8% to 18.7% respectively, whereas OECD countries have maintained fairly stable production in hydro power.



Nuclear power met heavy speculation in the practicality of operation of its power plants after the 2011 Japanese tsunami destroyed the plants, releasing tonnes of nuclear waste. Despite this tragedy, between 1971 and 2012, OECD countries were the largest producing region of nuclear power, although their share in production decreased from 92.8% to 79.2%.

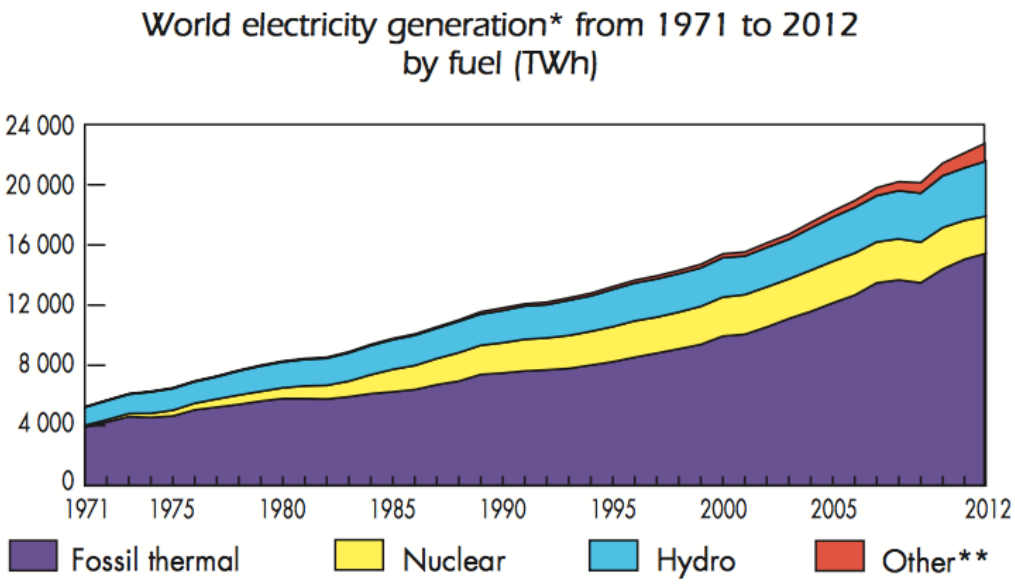


Non-OECD Europe and Eurasia, and China increased their nuclear power production share from 5.9% to 12.1%, and 0% to 4% respectively.

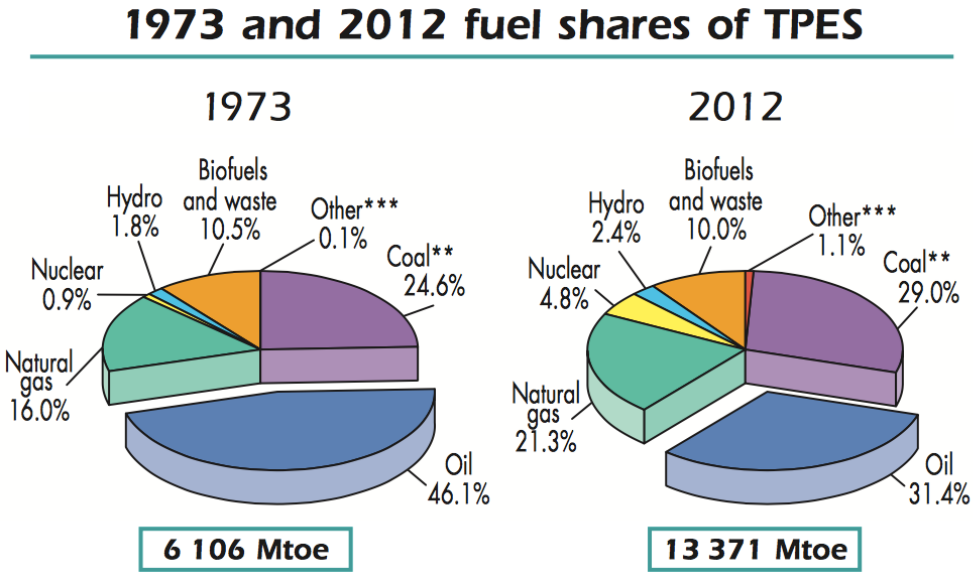


Links Between Consumption and Emissions

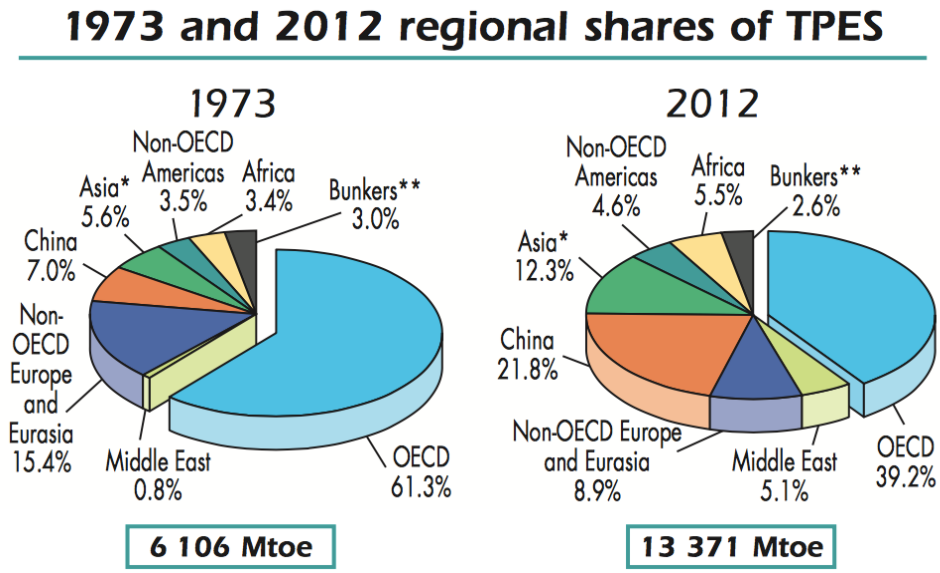
Taking a look at the 2012 world electricity generation by region since 1971, there is an understanding that the emerging economies have had, and will continue to have, a severe impact on energy source production, supply, consumption and emission production.



From 1973 to 2012, Total Primary Energy Supply (TPES) of natural gas supply increased by 5.3%, coal supply increased by 4.4%, and oil decreased by 14.7%, whereas hydro supply only increased by 0.6%, biofuel and waste actually decreased by 0.5%, and nuclear energy increased by 3.9%.

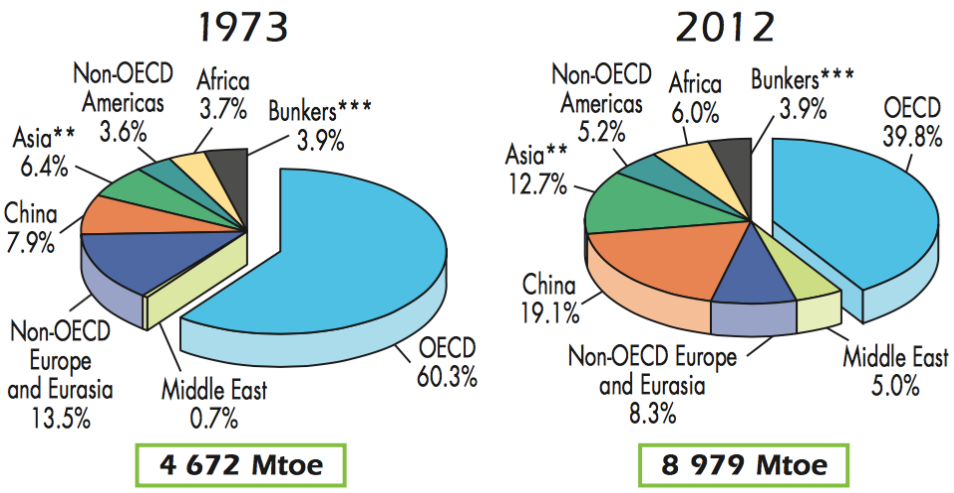


By region within the same time period, Total Primary Energy Supply (TPES) in the emerging economies of the Middle East, China, Asia, and Africa increased by 4.3%, 14.8%, 6.7%, and 2.1% respectively. TPES in OECD countries, non-OECD Europe and Eurasia, and non-OECD Americas changed with a decrease of 22.1% in OECD, a decrease of 6.5% in non-OECD Europe and Eurasia, and a slight increase of 1.1% in non-OECD Americas.

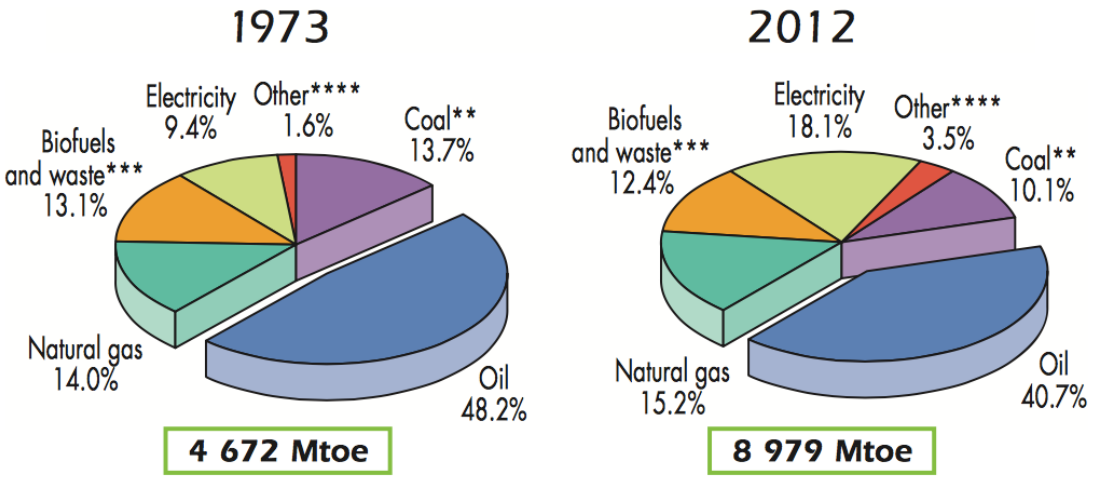


Putting all this information together, the final consumption concludes the key data. Without surprise, the Middle East, China, Asia and Africa have the largest increases in share of consumption compared to the rest of the world. Natural gas, electricity, and other, which includes agriculture, commercial and residential, and public service, are the sources that experienced the biggest increase in share of consumption.

1973 and 2012 regional shares of total final consumption*

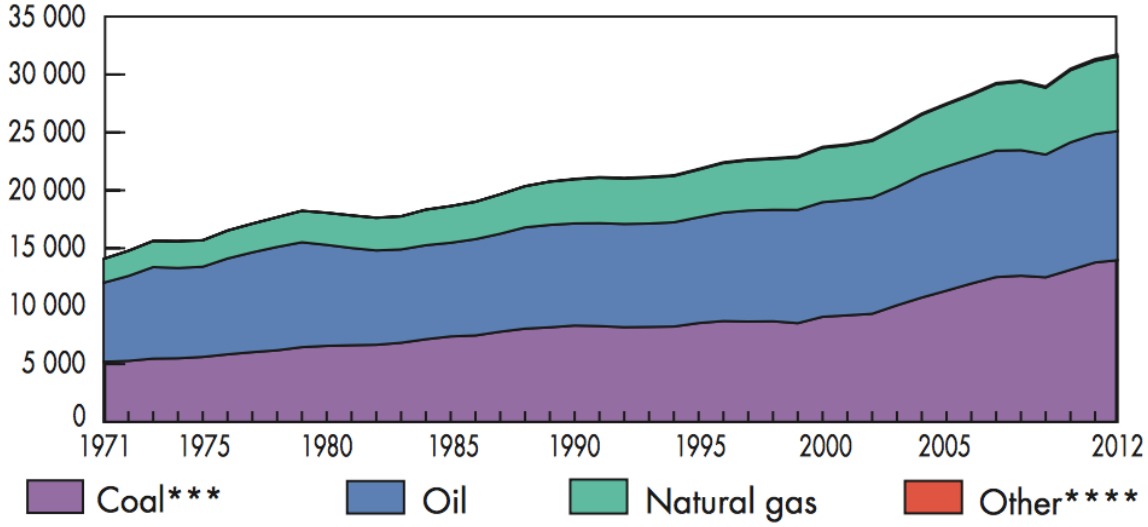


1973 and 2012 fuel shares of total final consumption

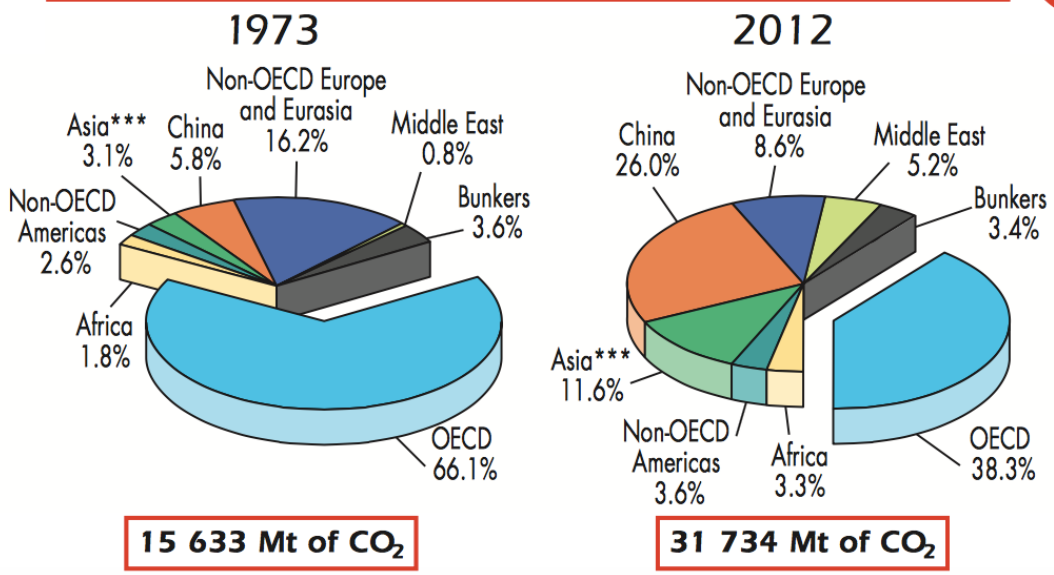


To date, coal and natural gas contribute to the highest increases in emission production of CO2, where OECD and non-OECD Europe and Eurasia nearly half their initial contribution to share of emissions by region, while China, Asia and the Middle East greatly increase.

World* CO_2 emissions** from 1971 to 2012
by fuel (Mt of CO_2)



1973 and 2012 regional shares of CO_2 emissions**



The energy debate begins with these statistics; developed countries with mature economies are delving into less energy intensive supplies, reducing their shares of production and supply of non-renewable energies. On the other hand, developing countries are in the midst of rapidly expanding economies and population, requiring cheaper fuels with existing infrastructure. The problem here is that, even though developed countries may be reducing their intensity and shares of production and supply of carbon-based fuels, the carbon offsetting is void due to developing countries' economic and energy demand requirements.

METHODOLOGY

Any event is considered a risk if it deviates from what is expected, including positive and negative results, referred to as upside and downside risk. Usually when something is mentioned as being risky, or when firms experience risk in business, the effect is often construed as negative. However, positive effects can offset a downside risk. The net effect is when both upside and downside risks are taken into account and weighted.[18] All increased costs and benefits that deviate from the expected outcome, or the baseline scenario, are included, producing a number of possibilities. The most commonly assessed include very pessimistic, pessimistic, optimistic, and very optimistic scenarios.

Although ERM faces the two challenges of confusion and a lack of leading practices in the marketplace, where traditional risk management products are mistakenly deemed as value-based ERM, using a value-based ERM model means each risk scenario is assessed with an integrative, holistic approach. In fact, ERM is defined as a process that identifies, measures, manages, and discloses key risks to increase value to stakeholders.[19] ERM aims to address risks from all risk sources, measure the integrated impact of risks occurring simultaneously, aggregate exposure to the enterprise level, define the risk appetite of the enterprise, and integrate risk information into decision-making, business performance analysis, and incentive compensation.[20] Value-based ERM risk sources include strategic, operational, and financial risk and strategy. By definition, financial risks are unexpected changes in external markets, prices, rates, and liquidity supply and demand; strategic risks are unexpected changes in key elements of strategy formulation or execution; and operational risks are unexpected changes in elements related to operations, such as human

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[18] Sim Segal, *Corporate Value of Enterprise Risk Management,* p. 21.

[19] Ibid., p. 24.

[20] Vittorio Vecchione, "Session 1: Course Overview - ERM Introduction." Risk Management, Winter 2015, LUISS Guido Carli University, Rome, Italy, [http://docenti.luiss.it/vecchione/files/2015/02/Session-1-Course-Overview-ERM-introduction.pdf], accessed March 4, 2015.

resources, technology, processes, and disasters.[21] These risks and subsequent strategies can be applied from an enterprise level to micro and macroeconomies in order to establish the relationships between businesses, national governments, and international cooperation. Traditional policy makers have too often attempted to create international policies that follow a top-down method; using ERM in policy making creates an integrative, bottom-up approach. Using this methodology, policy creation that encourages each country to sign, ratify, and participate in international climate policy mitigation can be achieved.

Evidence of current trends suggest that there is significant, global concentration risk in non-renewable energy sources, opening up real concern of severe risks to businesses, governments, and international dependency. For example, with the recent drop in oil prices, oil exporting countries, such as Venezuela, have had a particularly challenging economic obstacle to overcome. As cheaper substitutes emerge from oil consuming countries, such as the United States' production of natural gas, Venezuela has experienced severe shortages in the importing of necessary commodities. Crude oil exports account for 95% of foreign earnings, and exports dropped 60% in seven months, placing Venezuela on the verge of default.[22] With respect to the three types of risk, the global oil market experienced an unimaginable drop in the market price, due in part to the substitution of natural gas for oil, but primarily due to an oversupply and under demand of oil in historically large oil-consuming countries, such as OECD countries. Strategically speaking, Venezuela's exporting GDP relied much too heavily on their exploitation of oil; the country carried all their eggs in one basket. Without this key export, the country cannot afford the costly price to import the goods that Venezuelans need, but that the country does not produce itself.[23] Despite this, factories, refineries

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[21] Sim Segal, *Corporate Value of Enterprise Risk Management,* p. 27.

[22] Anatoly Kurmanaev & Andrew Rosati, "Condoms at US$755 show Venezuela reeling from plunging oil prices" Financial Post, February 5, 2015 [http://business.financialpost.com/news/economy/condoms-at-us755-show-venezuela-reeling-from-plunging-oil-prices], accessed February 2015.

[23] Ibid.

and businesses operating in Venezuela have the advantage to operate their businesses off of cheap oil because of the market price decrease; an upside risk. However, these exact same businesses may be in dire danger with respect to their bottom lines if many other goods required in their businesses are sourced from Venezuelan imports; another downside risk. If, for instance, Venezuela had a more diversified range of exports and national energy sources, the country would not be as close to default as they are now.

Nevertheless, value-based ERM uses a holistic approach; the market price drop in oil has global risks as well. The drop in price means that emerging economies that previously used other sources of energy can now better afford, import, and consume oil. With regards to emission production, emerging economies consuming this oil may negatively offset the decrease in consumption and production of oil emissions, placing the earth systems back in jeopardy.

With respect to the use of ERM methodology, the risk scenarios will first take into consideration the microeconomic effects, the macroeconomic effects, and finally, the international and global effects that will result in a correspondence to four key policy scenarios. The baseline scenario will refer to the Business As Usual case (BAU), with the hypothesis of continuing current trends in population, economy, technology, and behaviour. BAU includes already planned efficiency improvements. The optimistic scenario will refer to the New Policy Scenario case (NPS), a "scenario in the World Energy Outlook that takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments have yet to be identified or announced".[24] The very optimistic scenario will refer to the 450 Ideal Policy

[24] International Energy Agency, "Publications: Scenarios and Projections," http://www.iea.org/publications/scenariosandprojections/, accessed April 2015.

Scenario case (450), a "scenario presented in the World Energy Outlook that sets out an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of greenhouse gases in the atmosphere to around 450 parts per million of CO2."[25] The pessimistic scenario will be briefly analyzed in terms of the estimated graphical increase of temperature and CO2. There is not an abundance of information regarding the pessimistic scenario, as climate policy would have to go completely and extremely awry to accelerate the increases of the estimates from the baseline. Therefore, a very pessimistic scenario will not be analyzed within this research. The purpose of heavily focusing on the baseline, optimistic, and very optimistic scenarios is to draw specific attention to the problems of concentration risk in non-renewable energy sources, and encourage creation of international climate policy cooperation with better integrative and incentivized strategies; the carrot rather than the stick. By conducting policy negotiation in such a way, readdressing risk and subsequent strategy can be a continual and evolving process following a cyclical pattern, where successful implementation will result in significantly better compliance from a regulation standpoint.

[25] Ibid.

THEORY OF ECONOMICS

Any integrative climate policy mechanism must begin intertwining at the very roots of economies. For instance, before doctors can understand the relationships between bodily organs to diagnose ill patients, they must first have a firm understanding of the human body at a cellular level. Similarly, to encourage climate policy participation at a local, regional, national, and international level, having the ability to grasp the decision-making logic behind rationally behaving businesses is integral.

In this case, the basis behind the inner workings of businesses is microeconomics: demand, supply, price, long run, short run, etc. Most importantly, microeconomics explains firm dynamics with respect to maximizing profits and acting in self-interest. We see this in businesses every day; markups are placed on t-shirts in clothing stores so the store can increase their profit, offsetting the costs to manufacturing, packaging, and transporting the clothes. However, there is a great need for delicate balance in microeconomies, otherwise inefficiencies occur and markets fail.

Macroeconomics is equally as important as microeconomics in order to fully understand the implications of the lack (or existence) international climate policy would have at each level of an economy. The macroeconomy and the microeconomy are so closely linked, if shocks to either take place, the other will be affected. Furthermore, specific industries have immense lobbying power over governments, affecting macroeconomic policy. In Canada, oil and gas companies are very powerful firms operating in a historically profitable industry in which the Conservative government wishes to take full advantage. This type of favourable relationship between industry and government results in fewer restrictions, more subsidies, and heavy reliance in employment rates, price indexes, and exports.

Global energy demand poses a monumental challenge for implementing and encouraging participation in the climate debate. When it comes to the renewable energy market, renewable technologies tend to be left to the way side for a number of reasons; renewable technologies have an initially higher cost to implement, and many breakthroughs are still being made in both the testing and usage phases to realize their full potential. Furthermore, it is a common belief that renewable energy technologies alone are incapable of satisfying the energy demand. However, the two climate scenarios. NPS and 450, will show how the cooperative implementation of market instruments can vastly alter behaviour in market participants, versus a top-down imposition of legislative instruments. Before analyzing the different mechanisms and instruments, and their effectiveness, the theory of economics in preparation for market policy tools must be established.

MICROECONOMICS

Competition

Usually, the very first lesson of economics is describing perfectly competitive markets; homogenous products, a perfectly saturated market in terms of buyers and sellers, perfect information, and free firm entry and exit. As a result, firms in perfect competition are price takers, facing a negatively correlated demand curve and a positively correlated supply curve. In the short run, only partial adjustments of inputs can be made, whereas in the long run, all inputs can be altered to fit conditions.[26]

In the long run, perfectly competitive markets make no profit due to short run profits attracting new entrants into the industry, causing an increase in industry supply and market price to fall. Monopolistic markets, on the other hand, are sole suppliers in their industry and are price setters. Because a monopolistic firm can set price, monopolies are profit maximizers and are protected by some form of barrier to entry, such as a patent.[27]

The most notable difference between perfect competition and monopolies is efficiency. In perfect competition, no profit is made or lost, and inputs to outputs are maximized. In monopolies, deadweight loss is created due to monopolies' price setting abilities.

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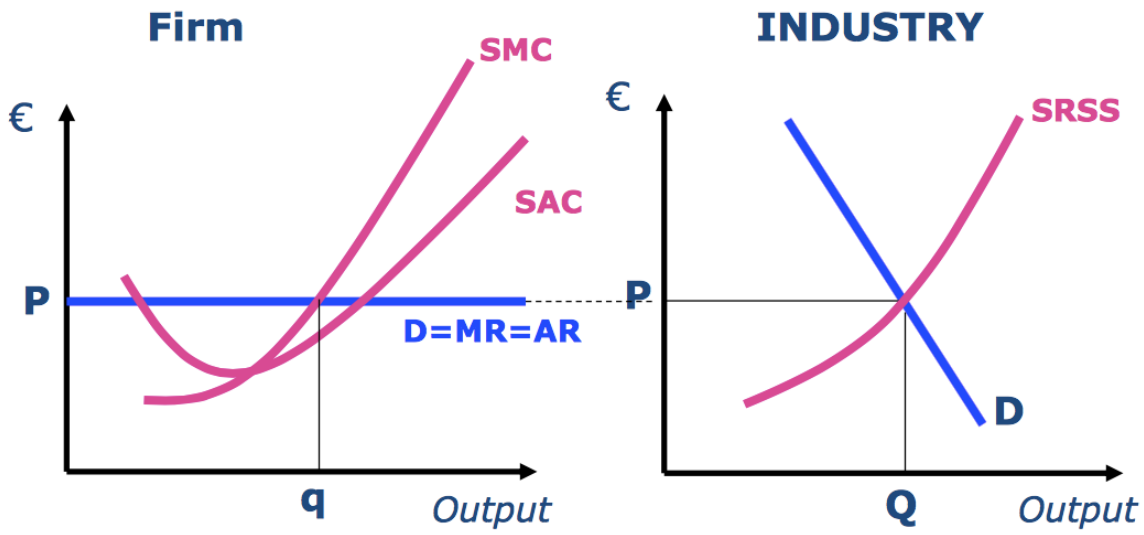
[26] Simone Mori, "Lecture 4: Regulatory Economics." Economics and Management of Energy Business, Fall 2014, LUISS Guido Carli University, Rome, Italy, [http://docenti.luiss.it/mori/files/2014/09/4-Regulatory-economics.pdf], accessed March 17, 2015.

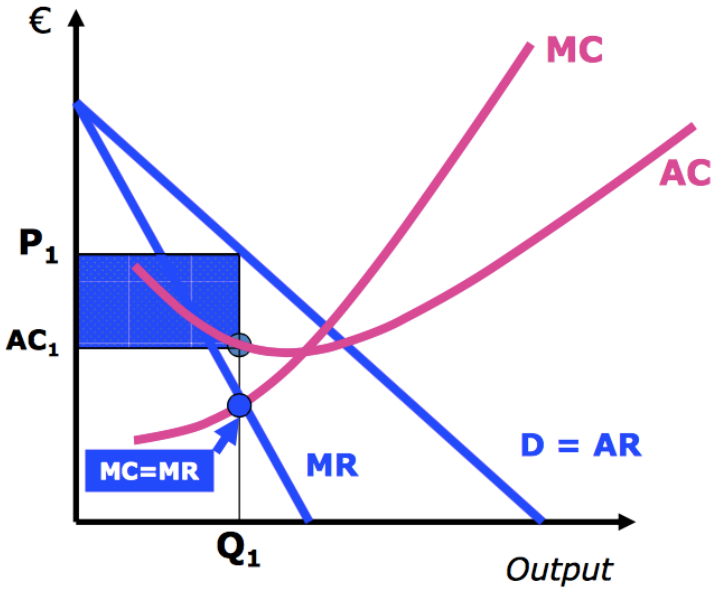
[27] Ibid.

1. Perfect Competition



(**Source**: Simone Mori, "Lecture 4: Regulatory Economics." http://docenti.luiss.it/mori/files/2014/09/4-Regulatory-economics.pdf, accessed March 17, 2015.)

2. Monopoly



(**Source**: Simone Mori, "Lecture 4: Regulatory Economics." http://docenti.luiss.it/mori/files/2014/09/4-Regulatory-economics.pdf, accessed March 17, 2015.)

Deadweight loss is a loss of economic and allocative efficiency. Monopolies can improve both their profits and the burden of deadweight loss by price-discriminating, a pricing mechanism that is much like what you would find with respect to ticket prices at your local cinema, where children and seniors are admitted at a lower prices than adults. In reality, perfect competition cannot be found. However, understanding the basics behind perfectly competitive markets and monopolies will aid in understanding how to improve economic and allocative efficiency at firm and industry levels, and subsequently at national and international levels.

Much like when price ceilings or price floors are placed on a firm or market, abatement undertaken by firms can be costly and increase deadweight loss if firms do not act proactively. Hypothetically, for example, a train transporting a large shipment of oil from systematically important oil producing companies crashes and spills the entire contents of the shipment. Consequently, these firms may experience tight supply constraints, affecting the demand and market price of oil. A change in market price, as previously mentioned, is a resulting risk that deviates from the expected price, and even a temporary shock to market price could significantly reduce company revenues. In fact, from the recent oversupply of oil in the Middle East, we have been witness to these practical effects for ourselves.

Social Welfare

Welfare economics is an expansion on efficiency in a societally inclusive sense. Realistically, every action a firm or a government takes will have a cost and a benefit, and no matter the decision or action, there will be some sort of deadweight loss associated. The term ‘Pareto-efficiency’ is used in this case instead to describe the best possible situation for where no one individual can be better off without making at least one other individual worse off, even if a deadweight loss is produced (in perfect competition, Pareto-efficiency and allocative efficiency is maximized).

The first theorem of welfare economics states the following three conditions must be met if a competitive equilibrium is Pareto-efficient: 1) consumers and firms must behave in a competitive way in all markets; 2) markets must exist for all exchanged goods; and 3) operators must receive perfect information.[28] If one or more of these conditions are not met, Pareto-efficiency cannot occur and allocative efficiency cannot be guaranteed. To understand how welfare economics relates to the riskiness of the international policy debate, externalities must first be established.

Externalities are costs or benefits that affect a party, or in this case, society, without the choice of whether or not to incur those costs or benefits. A positive externality "exists when an individual or firm making a decision does not receive the full benefit of the decision."[29] In other words, society benefits more than the firm. In positive externality situations, less quantity is produced and consumed than the Pareto-efficient equilibrium, and consumers actually pay less.

For example, immunizations are positive externalities. Not only do immunizations prevent individuals from contracting the disease, society benefits from the inability of spreading the disease further. Subsidizing positive externality goods is an effective way to encourage consumers to utilize these goods more, while increasing the marginal benefit.[30]

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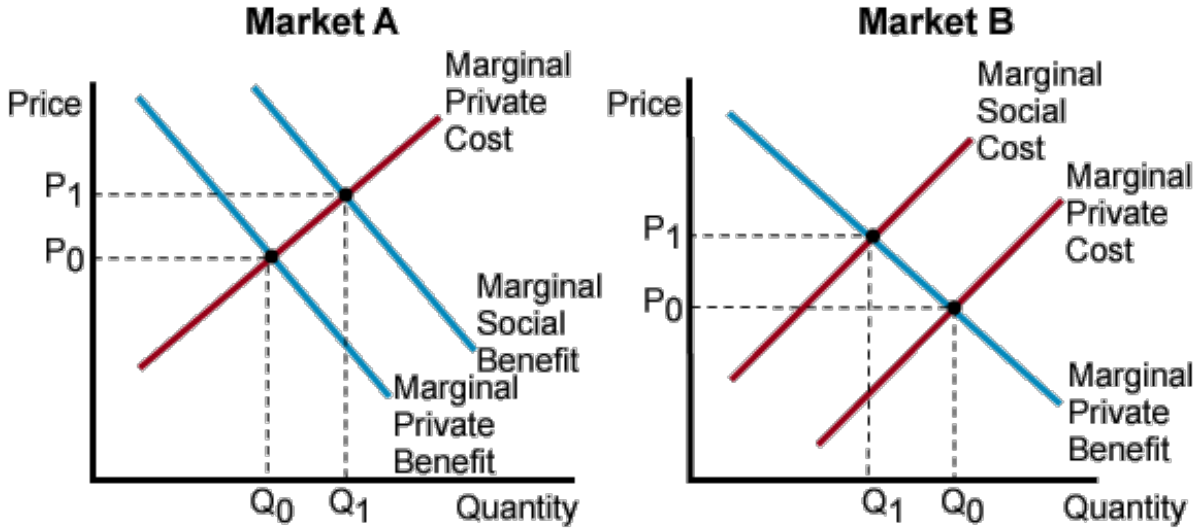
[28] Simone Mori, "Lecture 4: Regulatory Economics."

[29] Fundamental Finance, "Positive Externality," http://economics.fundamentalfinance.com/positive-externality.php, accessed March 2015.

[30] Ibid.



(**Source**: Freedom This Time, "Externalities," https://freedomthistime.files.wordpress.com/2011/12/externalities.gif, accessed June 2015.)

Conversely, negative externalities "occur when an individual or firm making a decision does not have to pay the full cost of the decision."[31] This means the cost to society is much more than the cost the consumer incurs, or the price the consumer pays. In negative externality scenarios, producers do not take responsibility for the external costs that society eventually ends up paying for. For example, when an individual smokes a cigarette, other people around the smoker incur the negative ramifications to their comfort and health, resulting in a higher number of cases of lung cancer. However, the producer of the cigarettes the smoker is consuming does not pay for the expenses that result from increasing cases of lung cancer. With lower marginal cost curves, firms participating in negative externality production produce more in quantity than is Pareto-optimally efficient, and more is sold. Thus, there is a deadweight welfare loss.

Negative externalities are particularly important, because in many ways, it is easier, cheaper, and more profitable for companies to operate in this way. Companies are let off the hook for producing

[31] Fundamental Finance, "Negative Externality," http://economics.fundamentalfinance.com/negative-externality.php, accessed March 2015.

goods or services that come hand-in-hand with hindering the health of society. Specifically, in non-renewable energy production, goods are not priced with the negative carbon effect, and as such, these goods are mass produced and consumed. The negative externalities from non-renewable energy production include all climate related risks that can and will accelerate without a mechanism that penalizes firms and consumers that engage in the production and consumption of these goods.

Although it has been "shown that the first generation to be made better off by these policies will not be born for more than 50 years after the policies are imposed,"[32] if nothing is done today to limit these firms, the world risks global collapse in both financial markets and structure, costing billions more dollars to fix and rebuild than if firms and nations accepted abatement.

Market Failure

Externalities are a big part of market failure; positive externalities create additional benefits to societally Pareto-efficient equilibria, and negative externalities create additional costs. However, these are not the only sources of market failure; the presence of imperfect—or asymmetric—information such as moral hazard and adverse selection, free riding and tragedy of the commons in public goods, market power, and lack of markets are important market failures to consider. We are currently experiencing many of these market failures on a daily basis, and thus, these failures require intervention.

1. Asymmetric Information

In a situation involving asymmetric information, one party takes advantage over another party, due to either hidden information or hidden action. Adverse selection is when the party—or firm—that is being regulated deliberately fails to disclose all relevant information to the party—or government—

[32] Andrew J. Leach, "The Welfare Implications of Climate Change Policy" (PDF file), downloaded from neumann.hec.ca, [http://neumann.hec.ca/pages/andrew.leach/leach-olg.pdf], accessed March 1, 2015.

regulating the industry in order to increase profit.[33] Moral hazard is when the firm assumes hidden actions that the government cannot control or anticipate.[34]

Asymmetric information is a very prevalent market failure that is especially difficult to monitor. It can be easy for a firm to engage in failing to disclose pertinent information that could be used to otherwise penalize. For example, simplistically, if a company under emissions taxation fails to disclose the full extent in which it produced a certain quantity with natural gas versus biomass, it receives a lesser taxation than it would have if the company had fully disclosed. The regulator would be less the wiser, unless it conducted a full audit. In order to mitigate adverse selection or moral hazard, an incentivizing structure that encourages firms to disclose all information and action taken, including costs, is necessary.

2. Public Goods

Public goods are characterized by being "non-exclusive" and "non-rivalrous" products. This means that a public good is something that is available to any one person without reducing the availability of the good to anyone else, and where no one is excluded from accessing and/or using it. Examples of public goods are public parks, national defence, and public radio broadcasts.

The notorious issue with public goods are peoples' justification to free-ride. Economics shows that "a rational person will not contribute to the provision of a public good because he does not need to contribute in order to benefit."[35] Extending this matter to businesses, most often companies' shareholders define their success based off profit and dividend payout. This is not necessarily a bad

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[33] Simone Mori, "Lecture 4: Regulatory Economics."

[34] Ibid.

[35] Investopedia, "Public Good," http://www.investopedia.com/terms/p/public-good.asp, accessed March 2015.

definition, but a rigid focus on these financial items can hinder consumer welfare if, to gain profit, unsocially responsible measures are taken (such as cheap labour or cheap, harmful energy sources). Thus, some companies have a tendency to free-ride on the benefits of socially responsible companies, whose mission is not only to provide appealing returns, but also to ensure future generations' success. This is referred to as generational free-riding and it "occurs because most of the benefits of emissions reductions today would accrue many decades in the future."[36] Therefore, shareholders purely concerned about next quarter's profits will not concern themselves with today's extra costs of emissions reductions, even though it may provide twice as much profit in the relatively distant future.

Tragedy of the Commons is another familiar problem behind public goods; each person utilizing a common—or shared—space attempts to reap the most benefit of that space at the cost of diminishing supply so severely, others who try to reap benefit from the same space can no longer receive the same benefit. In other words, this phenomenon occurs when individuals neglect the well-being of society in the pursuit of personal gain. This can be illustrated by imagining a large field, where a portion of that field is privately owned, and the rest is publicly available.[37] In the privately owned land, the owners who bring their livestock to graze here switch grazing sections, so that the parts that have been consumed by the livestock can have time to recover and regrow. The owner of this land has incentive to be responsible for the wellbeing of his land. On the other hand, the public field is not owned by anyone and thus, no one has a duty of care to this part of the field. So herds feed and graze here, not just according to his or her needs, but to the self-interest of the individuals who own each herd. With no control, the herd numbers grow, continually grazing on the land, until the increase in herds exceeds the carrying capacity of the public field, completely

[36] Nordhaus, *The Climate Casino*, p. 8.

[37] Garrett Hardin, "Tragedy of the Commons," econlib.org, [http://www.econlib.org/library/Enc/TragedyoftheCommons.html], accessed March 2015.

depleting the resource.[38] This disaster is more or less what our earth systems are facing today, as we are drawing ever more near to greatly exceeding the carrying capacity of the world in population, over farming, over extraction, and most notably, critically increasing temperature.

3. Excess Market Power & Lack of Market

Having a firm in the market with too much power calls for cause for intervention. Oligopolies and monopolies are both markets that possess excess market power, where the price is not fixed equal to marginal cost, preventing markets from achieving allocative efficiency. Such firms overcharge and underproduce. Although it can be difficult to monitor and regulate true monopolies, natural monopolies are the easiest targets for regulation.

Natural monopolies occur when the most efficient firm in the industry experiences the greatest increase in output with the greatest decrease in average cost; such great economies of scale occur that only one firm can survive production without suffering losses. Companies that have this power eliminate competition and allocative efficiency, leaving little room to provide substitutes that are present in competitive markets. Limited substitutes, specifically in the energy industry, causes companies and governments to stick to the infrastructure that has been in place for decades, reducing—and in some cases, abandoning—semblances of emission mitigating technologies and infrastructure.

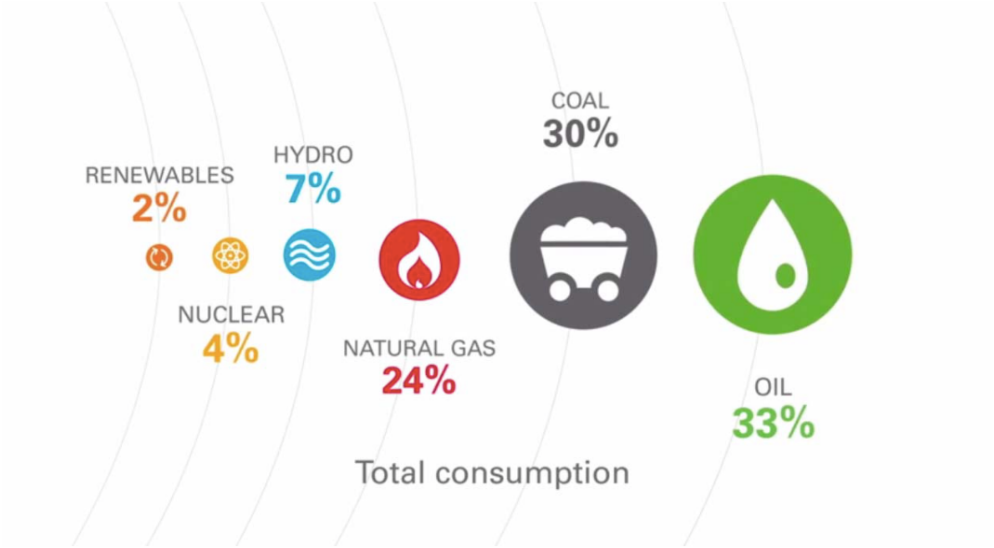
Furthermore, not all goods have their own place in any market, such as environmental resources and facilities. For example, a futures market for oil exists today, and the market should efficiently

[38] Ibid.

allocate this oil from now to 2050. If, in the long run, there is no futures market for oil, producers will produce everything they possibly can now, and will not leave much left for the future.[39]

Where there once was never a market for emissions reduction, there now exists markets for emissions reduction products such as cap and trade, or even tree planting to offset a carbon footprint. However, the markets for non-renewable and wasteful technologies vastly outweigh and overshadow the markets for renewable and recycling technologies; although the world has realized the largest growth in hydro, wind, and solar energy, renewables still only account for two percent of global energy consumption.[40]

Thus, today's development and increases in these markets is necessary in reducing emissions and achieving better allocative efficiency.



(**Source**: Simone Mori, "Lecture 2: Global Energy Trends." http://docenti.luiss.it/mori/files/2014/09/2-Global-Energy-Trends-Sola-lettura.pdf, accessed March 17, 2015.)

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[39] Edward Morey, "An Introduction to market failures," (PDF file), downloaded from colorado.edu [http://www.colorado.edu/economics/morey/4545/introductory/marketfailures.pdf], accessed 15th March 2015.

[40] Simone Mori, "Lecture 2: Global Energy Trends." Economics and Management of Energy Business, Fall 2014, LUISS Guido Carli University, Rome, Italy, [http://docenti.luiss.it/mori/files/2014/09/2-Global-Energy-Trends-Sola-lettura.pdf], accessed March 17, 2015.

Intervention can either happen ex-ante or ex-post. Ex-ante intervention and regulation is conducted through access regulation (authorizations, licenses, liberalizations), price controls, obligatory information disclosure, and economic incentives. Ex-post regulatory intervention is primarily through anti-trust interventions to penalize anti-competitive behaviour and abuse of dominant position.[41] Various levels of intervention have occurred all over the world. For example, in the United States, free markets are believed to be able to work things out on their own without much intervention, whereas in the United Kingdom, a much higher level of government intervention is utilized.

Game Theory

For those who have studied microeconomics, many have learned about game theory, which is the focus on how groups of people, or in this case, firms, act and react. Game theory deals with two kinds of groups: noncooperative and cooperative. Noncooperative game theory studies how firms interact when they are focused on their own self interest,[42] whereas cooperative game theory studies how firms interact when they are working toward a collective goal.

Prisoner's Dilemma is a special situation that describes a firm's incentive to cheat. Imagine two thieves, Thief A and Thief B have just been arrested and put in separate investigation rooms to be questioned by two detectives. Both detectives give Thief A and Thief B the following options; confess or do not confess. If they both remain silent, Thief A and Thief B go free, split the proceeds of their crime 50/50 and each receive positive utility of '5'. If both confess, neither go free but they do receive a shorter term, represented by a positive utility of '1'. However, if one thief confesses, but not the other, one thief keeps all the profit from the crime and is set free, while the other

[41] Simone Mori, "Lecture 4: Regulatory Economics."

[42] David K. Levine, "What is Game Theory?," levine.sscnet.ucla.edu, [http://levine.sscnet.ucla.edu/general/whatis.htm], accessed April 2015.

receives none and goes to jail for the full sentence. In cooperation, the best option would be to remain silent, go free, and split the profits. But when the thieves are placed in separate rooms, unsure if their partner will confess before they do, there is a very strong incentive to be the first to confess.

Thief A

Thief B	***PRISONER'S DILEMMA OUTCOMES (FN)***	Cooperate (Do Not Confess)	Do Not Cooperate (Confess)
	Cooperate (Do Not Confess)	5,5	-4,10
	Do Not Cooperate (Confess)	10,-4	1,1

(**Source**: David K. Levine, "What is Game Theory?," http://levine.sscnet.ucla.edu/general/whatis.htm, accessed April 2015.)

On the other hand, economists have studied the possibility that the idea behind the phrase "if we were all better people, the world would be a better place" is actually false.[43] The Pride Game, a slight variation of the Prisoner's Dilemma but played much differently, helps to demonstrate the outcomes of proud and altruistic criminals. The existence of pride, a feeling that one has superior dignity, importance, and/or qualities, is one of many reasons people, businesses, and governments tend to conflict over various issues. Pride, in some sense, is quite similar to nationalism in that certain countries believe themselves better than others, and as such, should not be bound to the same standards. In the Pride Game example, the proud thief would only confess in retaliation to the other thief that confessed first. For example, if Thief A confessed, Thief B would act proud, and

[43] Ibid.

humiliate Thief A for confessing first. Therefore, Thief A would receive no utility and Thief B would receive 1.5 for not confessing and being proud. If both Thief A and Thief B act proud and neither confess, their utility is hindered as each thief is trying to humiliate the other.

Thief A

PRIDE GAME OUTCOMES (FN)	Proud	Cooperate (Do Not Confess)	Do Not Cooperate (Confess)
Proud	4,4	5.4,3.6	1.2,0
Cooperate (Do Not Confess)	3.6,5.4	5,5	-4,10
Do Not Cooperate (Confess)	0,1.2	10,-4	1,1

Thief B

(**Source**: David K. Levine, "What is Game Theory?," http://levine.sscnet.ucla.edu/general/whatis.htm, accessed April 2015.)

Nevertheless, if the thieves were better people—or more altruistic people—the thieves are less concerned about their self-interest and more in the interest of their partner in crime. In the more selfish Pride Game, twice as much weight was placed on utility in self-interest, whereas in the more Altruistic Pride Game, two thirds of the utility is placed on self-interest, and one third is placed on the other player. Therefore, if Thief A is proud, Thief B would choose not to confess, and vice versa. So it would be better if both thieves chose not to confess. However, if Thief A confesses, Thief B would no longer wish to act proud as a gain of '0.2' in self-interest would cost Thief B '1.' Therefore, Thief B would confess as well. Thus, if both Thief A and Thief B confess, utility equilibrium is at '1,1' which does not maximize their highest potential utilities.

Thief A

Thief B	***ALTRUISTIC PRIDE GAME OUTCOMES (FN)***	Proud	Cooperate (Do Not Confess)	Do Not Cooperate (Confess)
	Proud	4,4	4.8,4.2	0.8,0.4
	Cooperate (Do Not Confess)	4.2,4.8	5,5	0.55,5.5
	Do Not Cooperate (Confess)	0.4,0.8	5.3,0.67	1,1

(**Source**: David K. Levine, "What is Game Theory?," http://levine.sscnet.ucla.edu/general/whatis.htm, accessed April 2015.)

Game theory can be applied from this microeconomic level to international climate change policy. The Nationalist Dilemma is much like the Prisoner's Dilemma in that countries do not cooperate in ratification of a climate policy because abatement is too costly to undertake, so they free ride on the efforts of other countries who want to try to cooperate. For instance, the European Union (EU) has lead the way in climate policy in many respects. With the ratification and subsequent follow-through of emissions reductions with respect to the Kyoto Protocol targets, the EU's GHG per capita was already initially less than the GHG per capita of the US, who did not ratify the treaty. The Pride Game is the more complicated reality of the world, and the actions of the people who live in it. Altruism in the last game demonstrates how criminals would be forgiven for their behaviour, and how, although altruistic criminals may commit fewer crimes, punishment is more forgiving. Thus, criminals would be incentivized to commit more crimes. Currently, we see this vague glimmer of altruism in policy negotiations. After ratifying the Kyoto Protocol, with an emission reduction target of six percent lower than 1990 levels, Canada withdrew from the protocol. Canada

would have faced immense monetary penalties, as the nation's emissions actually grew by about 24.1 percent between 1990 and 2008.[44] Instead of being held liable through treaty fines and penalized for breaching emissions targets, Canada was let off scot-free and permitted to exit the Protocol.

[44] United Nations Framework Convention On Climate Change, "Report of the individual review of the annual submission of Canada submitted in 2010," (PDF file), downloaded from UNFCCC Website, [http://www.library.hbs.edu/guides/citationguide.pdf], accessed June 10, 2015.

MACROECONOMICS

Unemployment Rate

According to an MIT Joint Program on the Science and Policy of Global Change paper, "the politics of limiting greenhouse gas emissions are often dominated by relatively short term considerations. Yet the current economic modelling of emissions limitations does not embody economic features that are likely to be particularly important in the short term, in particular, the politically sensitive unemployment rate."[45]

Many countries, such as the US, believed that undertaking serious responsibility through ratification of international climate policy targets and mechanisms would damage their economy. This concern is one of a more political nature than a sincere interest for the environment and ecosystems; primarily expected short run effects are of major concern, specifically for political reelection in the US, rather than a concern over the climate consequences by the end of the century.

Furthermore, public perception of climate change in the US was of least concern among many other personal, social, and environmental needs. The highest needs of concern were lowering crime rates and making enough money to live comfortably.[46]

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[45] Mustafa Babiker and Richard S. Eckaus, "Unemployment Effects of Climate Policy," http://economics.mit.edu/files/2438, accessed April 2015.

[46] Anthony Leiserowitz, Global Public Perception, Opinion and Understanding of Climate Change: Current Patterns, Trends & Limitations (PDF file), downloaded from hdr.undp.org, [http://hdr.undp.org/en/reports/global/hdr2007-2008/papers/leiserowitz_anthony.pdf], accessed April 2, 2015.

	Not important	Midpoint	Important	Missing
Personal				
Having a secure and loving marriage	11	5	78	6
Making enough money to live comfortably	7	8	79	6
Feeling wanted and needed by friends and family	14	10	71	5
Social				
Lowering the rate of violent crime in country	5	9	81	5
Improving our nation's schools	8	12	75	5
Reducing poverty and homelessness	18	15	62	5
Eliminating the federal budget deficit	20	17	56	7
Maintaining a strong military	25	18	51	6
Environmental				
Reducing air and water pollution	11	14	69	6
Maintaining our national parks	15	18	61	7
Slowing the rate of global warming	**30**	**19**	**43**	**8**

(**Source**: Anthony Leiserowitz, "Global Public Perception, Opinion and Understanding of Climate Change: Current Patterns, Trends & Limitations", http://hdr.undp.org/en/reports/global/hdr2007-2008/papers/leiserowitz_anthony.pdf, accessed April, 2015.)

What these surveyed Americans failed to realize is that, without a well-functioning earth, many resources and systems fail, such as lumber, oil extraction, extinction of species, etc. If these systems fail, unemployment in these once booming sectors sky rocket, and the once highest needs of concern become null and void.

Limiting greenhouse gas emissions involving emission tax, emissions trading, or compliance controls are significant changes to an economy that affects and shifts employment, and thus unemployment. Variations in unemployment rates are predominantly due to increased globalization, the rise and fall of significant industries, and the rapid growth of the technology sector.[47] With increased globalized and the introduction of so many different technology markets, labour is increasingly diverse within niche skill sets. Although people are fairly free to move across markets, across countries, and across industries, some particular sets of skills cannot be easily transferred; farmers cannot simply transfer effortlessly into a mobile-tech specific industry, just as a miner could

[47] Mustafa Babiker and Richard S. Eckaus, "Unemployment Effects of Climate Policy"

not relocate to an industrial engineering position without difficulty.[48] Therefore, policy changes must evaluate and take into consideration this labour rigidity.

Nevertheless, conventional energy sources (coal, oil, and natural gas) are sectors that look to have a terminal future. For instance, the North Sea's historic field of Brent Crude Oil is currently experiencing decommissioning of three offshore oil platforms; Brent Alpha, Brent Bravo, and Brent Delta. Royal Dutch Shell's four platforms were inspected, where three out of the four platforms were "no longer viewed as economical."[49] By early May of 2014, only one platform remained in operation off of the United Kingdom Continental Shelf. Earlier this year, Shell's further decommissioning plans focused on Brent Delta. The oil produced along this shelf has been long used to gauge oil prices in this North Sea sector,[50] and approximately one tenth of all UK oil and gas has come from this oilfield since initial production in 1976.[51] What does this mean for employment? For the time being with respect to Brent Delta specifically, due to the mass scale of the decommissioning and services required offshore at these platforms, unemployment is not at risk for the next 10 years. However, once these platforms have been safely decommissioned and closed down for good, where are the thousands of platform workers going to go for work?

In Royal Dutch Shell's Brent Decommissioning Brochure, the hope is that a multi-billion dollar decommissioning industry will be developed, with hundreds of fields in the North Sea already scheduled for decommissioning by 2040.[52] The benefits focus on the growth in economy it could

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[48] Ibid.

[49] "Shell announces end of Brent Alpha and Brent Bravo production," 29 October, 2014, BBC News, http://www.bbc.com/news/uk-scotland-north-east-orkney-shetland-29821157, accessed 5 April, 2015.

[50] "Iconic Brent decommissioning plan unveiled by Royal Dutch Shell," 3 February, 2015, BBC News, http://www.bbc.com/news/uk-scotland-north-east-orkney-shetland-31096983, accessed 6 April, 2015.

[51] "End of a North Sea era: could the dismaying of Brent field spark a decommissioning bonanza for Scotland?," 22 February, 2015, Herald Scotland, http://www.bbc.com/news/uk-scotland-north-east-orkney-shetland-31096983, accessed 10 April, 2015.

[52] Royal Dutch Shell, "Decommissioning the Brent Field," (PDF file) downloaded from Shell website, [www.shell.co.uk/.../decommissioning-brent.../brent-project-brochure.pdf], accessed June 4, 2015.

bring the UK, and the benefits to local UK companies. In a way, this is a financially and environmentally positive trend in sectoral development away from offshore oil and gas production. Yet, there is mention of recycling the platforms' topsides. Thus, once all decommissioning is finalized and completed, and topsides have been recycled, what use is there any more for employment in the thousands? Yes, these decommissioning activities would perhaps take place 50 years or so into the future, but decommissioning also has a terminal future.

Renewable energy technologies that did not exist very long ago are now either in preliminary stages, testing stages, and/or marketing stages, which means an increased labour requirement gap that must be filled and can be grown into the ensuing future.

Price Indexes

A price index measures the change in price over a period of time for a certain bundle of goods and/or services. There are price indexes calculated for numerous things. The Consumer Price Index (CPI), describes the weighted average prices paid by consumers for a basket of goods over a certain period of time, usually monthly.[53] The Producer Price Index (PPI), describes the average selling prices for some given output for a basket of goods from the perspective of the seller.[54] These indexes are measured by movements from a base period set to 100, measuring percentage increases or decreases. CPI can help to indicate a period of inflation or deflation, whereas PPI can indicate areas in production that are growing or diminishing. For instance, the CPI can pinpoint seasonal trends in electricity averages in the US. Increases in the CPI were experienced each month from September until January, and decreased due to warming weather between February and March.[55]

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[53] Investopedia, "Consumer Price Index CPI," http://www.investopedia.com/terms/c/consumerpriceindex.asp, accessed March 2015.

[54] Investopedia, "Producer Price Index PPI," http://www.investopedia.com/terms/p/ppi.asp, accessed March 2015.

[55] Bureau of Labor Statistics, "CPI Detailed Report Data for March 2015," http://www.bls.gov/cpi/cpid1503.pdf, accessed April 2015.

The main differences between CPI and PPI arise from three areas: 1) composition of the set of goods and services; 2) types of prices collected for the included goods and services and; 3) coverage of the services sector.[56] PPI includes the whole of the marketed output of US producers, consisting of "goods, services, and construction products purchased by other producers as inputs to their operations or as capital investment, goods and services purchased by consumers either directly from the service producer or indirectly from a retailer, and products sold as export and to government."[57] The prices used in PPI calculations is based off of the revenue received by the producer, omitting sales and excise taxes that are not relevant to producer revenue. On the other hand, CPI includes the set of goods and services "purchased for consumption purposes" by urban households.[58] Intuitively, the price then used in CPI calculations consists of expenditures on the item of sale, which includes sales and excise taxes as these values are paid by the consumer in the transfer.[59] In the US, PPI does not yet have complete coverage in services, although this coverage is expanding. Thus, some consumer services that are not included in the PPI are placed in the CPI.[60]

As this data is comprised from Census data, CPI and PPI are important indexes to understand and use as reference to the consumption and production habits of the average citizen and industry. In this way, countries can best apply policy methods that would work well within their economies.

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[56] Bureau of Labor Statistics, "Frequently Asked Questions (FAQs): 4. How does the Producer Price Index differ from the Consumer Price Index?,)" http://www.bls.gov/ppi/ppifaq.htm#4 , accessed April 2015.

[57] Ibid.

[58] Ibid.

[59] Ibid.

[60] Ibid.

Interest and Exchange Rates

Interest and exchange rates are some of the most important factors used to determine a country's economic condition. If a country has a higher currency, said country will have more expensive exports and cheaper imports.[61] Conversely, if a country has a lower currency, said country will have cheaper exports and more expensive imports[62]. An exchange rate is meant to balance out these disparities in currency in trade; a higher exchange rate lower's a country's balance of trade, and a low exchange rate raises it.[63] Exchange rates rely on a number of elements, such as inflation and interest rates, deficits and debts, and terms of trade.[64]

Interest rates are another means of evaluating a country's ability to perform well. Central banks are the big influencers of interest and exchange rates, and changing bank interest rates can significantly affect currency values.[65] Higher interest rates attract foreign capital, which causes a subsequent increase in exchange rates, and vice versa, unless inflation rates impact the country's currency to the point of offsetting, or lowering currency. The existence and interrelation of these rates are important to consider when conducting international policy creation, especially when policies will affect countries with expected poor economic performance. These countries often find it challenging to meet its nation's economic needs, while also finding the resources to invest in renewable infrastructure and/or implement policy mechanisms. Countries whose economic health is unwell should not be free from climate mitigation policies, but in many cases, these countries become exempt regardless.

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[61] Investopedia, "6 Factors That Influence Exchange Rates," http://www.investopedia.com/articles/basics/04/050704.asp, accessed March 2015.

[62] Ibid.

[63] Ibid.

[64] Ibid.

[65] Ibid.

Imports and Exports

All over the world, every country has different sets of local resources. These local resources can create country-specific advantages, either in the resource itself or in other skills developed within the country. Such skills include the development of educational structures, highly developed infrastructures, and technological innovations.[66] If one country has an abundance in, for example, bananas, and another country has an abundance in technology but no bananas, these countries may wish to trade resources, which is the act of exporting and importing goods. Exporting and importing goods grows global markets and national economies, where exports are sales of goods from a domestic market to a foreign market and imports are foreign manufactured goods that are purchased by the domestic market.[67]

Imports and exports are necessary to businesses and consumers. Intuitively, countries would prefer to be net exporting countries, where they export more than they import, increasing national GDP. However, importing goods increases consumer choice, which often increases consumers' standard of living.[68] Net exporting countries spur domestic economic activity, which creates more production, jobs, and revenues.[69] However, if a country's imports exceed its exports, that country will run a deficit—just as a company would lose profit if it spent more money to produce a good than it received in the sale of those goods. Net importing countries heavily rely on the resources of other countries. When exporting countries are no longer able to produce the same output due to changing climate conditions, such as severe drought limiting supplies of corn or wheat, net importing countries lose access to these goods and commodities they are unable to produce.

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[66] Study.com, "Importing and Exporting in a Global Market: Definition, Process & Importance", http://study.com/academy/lesson/importing-and-exporting-in-a-global-market.html, accessed June 2015.

[67] Ibid.

[68] Ibid.

[69] Ibid.

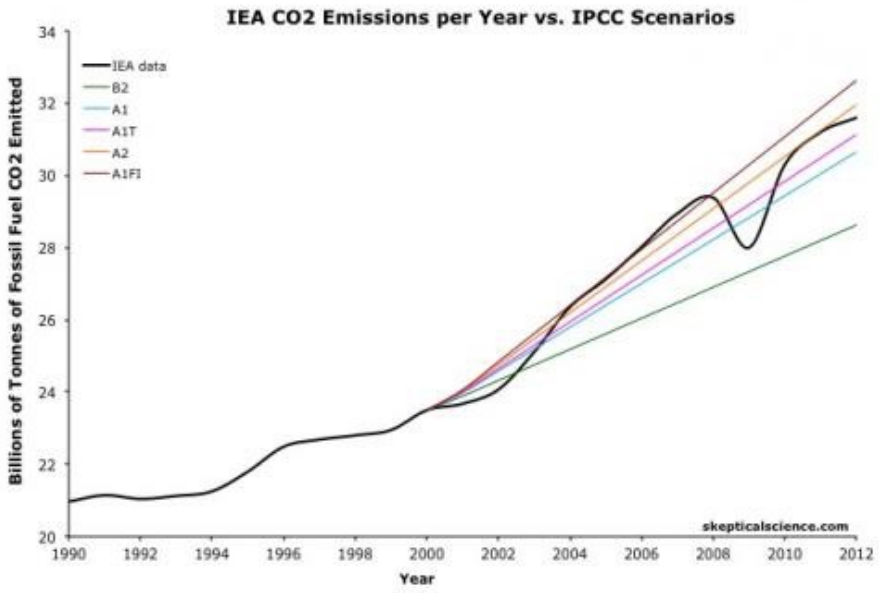
RISK

As previously mentioned, climate change can be a tricky topic to scale and to approach, made even more difficult by the challenges posed to the value-based ERM framework. Hundreds of levels of scenarios exist where countless experts, environmental professionals, and organizations advocate for variations in combinations of the possibilities and impacts of these different phenomena. Numerous climate models have been designed and used to predict the impacts from different levels of temperature increases, and increases in CO2 and other GHGs from human-bred activities. With the amount of heavily dispersed and available information on climate and climate policy stemming from grassroots organizations to formal organizations, such as the United Nations, to independent educated individuals, it seems near impossible to have all the knowledge required to accurately assess the key risk scenarios and resulting impacts.

Regardless of these challenges, there are some pretty important takeaways most experts have concluded over the last century: 1) the current CO2 concentrations are significantly greater than any level observed in the last 650,000 years; 2) the increase in global temperature from 1900 to 2100 is estimated with best evidence to be between 1.8 and 4.0 degrees celsius; 3) sea level rise estimates for the 21st Century is between 18 and 60 centimetres (excluding large ice sheets); 4) temperatures are expected to rise remarkably faster in the Arctic than global temperature; 5) by summer of the end of the 21st Century, the Arctic Ocean is predicted to be nearly ice-free; 6) increases in frequency and intensity of hurricanes; 7) acidification of the oceans as a result of CO2 concentrations; and finally, 8) extreme weather forecasts (increases in hotter or decreases in colder days).[70]

[70] Nordhaus, *The Climate Casino*, pp. 47-48.

From a policy framework perspective, the Intergovernmental Panel on Climate Change (IPCC), formed in 1988, produces reports that supports the United Nations Framework Convention on Climate Change (UNFCCC), which was formed later in 1992. The UNFCCC is the political body on climate change that produces protocols for countries to ratify, such as the Kyoto Protocol. In specific protocols like this one, the UNFCCC can set binding limits and penalize countries that are not making progress. However, outside of binding protocols, the UNFCCC has no enforcement mechanisms in place. The IPCC creates reports to provide evidence on climate projections. These are called Special Reports on Emissions Scenarios (SRES), which are more detailed scenario analyses than the International Energy Agency's (IEA) World Outlook. SRES contains 40 scenarios of which the five most important scenarios are shown in colour in the graph below. According to the collaboration between IEA data (shown in black) and the IPCC's SRES, we are on track with scenario A2 in yellow.[71]



(**Source**: Skeptical Science, "CO2 Emissions vs IPCC Scenarios," http://www.skepticalscience.com/graphics.php?g=20, accessed April 2015.)

[71] Skeptical Science, "CO2 Emissions vs IPCC Scenarios," http://www.skepticalscience.com/graphics.php?g=20, accessed April 2015.

Within IEA's World Energy Outlook Special Report, "Redrawing the Energy-Climate Map," the report "demonstrates that the energy sector, in its own interest, needs to address now the risks implicit in climate change – whether they be the physical impacts of climate change or the consequences of more drastic action later by governments as the need to curb emissions becomes imperative."[72] Nevertheless, the report also explicitly states that while an agreement to limit the average global temperature increase to two degrees celsius is estimated to emerge this year, no legal obligation will occur before 2020.

Recall that, according to the IEA, "the point of departure for the climate negotiations, due to reach climax in 2015, is not encouraging: [there exists] a continued rise in global greenhouse-gas emissions and stifling air pollution in many of the world's fast-growing cities."[73] Currently, the long-term average temperature increase is projected to be between 3.6 degrees and 5.3 degrees celsius, where limiting global temperature increase to two degrees remains conceivably attainable[74] with drastic action. This action must not only be legally required before 2020, but must be set into motion by all countries within this year to have a effective impact on average global temperature increase, as most increase will occur this century.

The biggest contributor to climate negotiations and the climate policy debate is the energy sector. In the IEA's Special Report, the report states the energy sector is largely based on consumption of fossil fuels; about 80 percent of global energy consumption is due to carbon-based fuels.[75] As in the IEA's Key Statistics of current trends, around two-thirds of GHGs results from emissions produced

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[72] International Energy Agency, "Redrawing The Energy-Climate Map," (PDF file), downloaded from IEA website, [http://www.iea.org/publications/freepublications/publication/WEO_RedrawingEnergyClimateMap.pdf], accessed 10 April, 2015.

[73] International Energy Agency, "World Energy Outlook 2014 Executive Summary."

[74] International Energy Agency, "Redrawing The Energy-Climate Map."

[75] Ibid.

from the energy sector. Non-OECD countries have increased their share of global emissions from 45 percent to 60 percent, and China was the biggest contributor to the increase in global emissions in 2012.[76] Recently, China has slowed its nation's growth given the increase in development of renewable energy technologies and energy intensity improvements. Regardless, from current trends, China is still a prominent player in the energy-climate debate. On the other hand, although the United States did not take part in the Kyoto Protocol, the Obama administration has taken nationwide steps to reduce emissions, by switching from coal to gas in power generation. This has helped to reduce GHG emissions by 200 million tonnes to bring the US back to mid-1990's levels.[77]

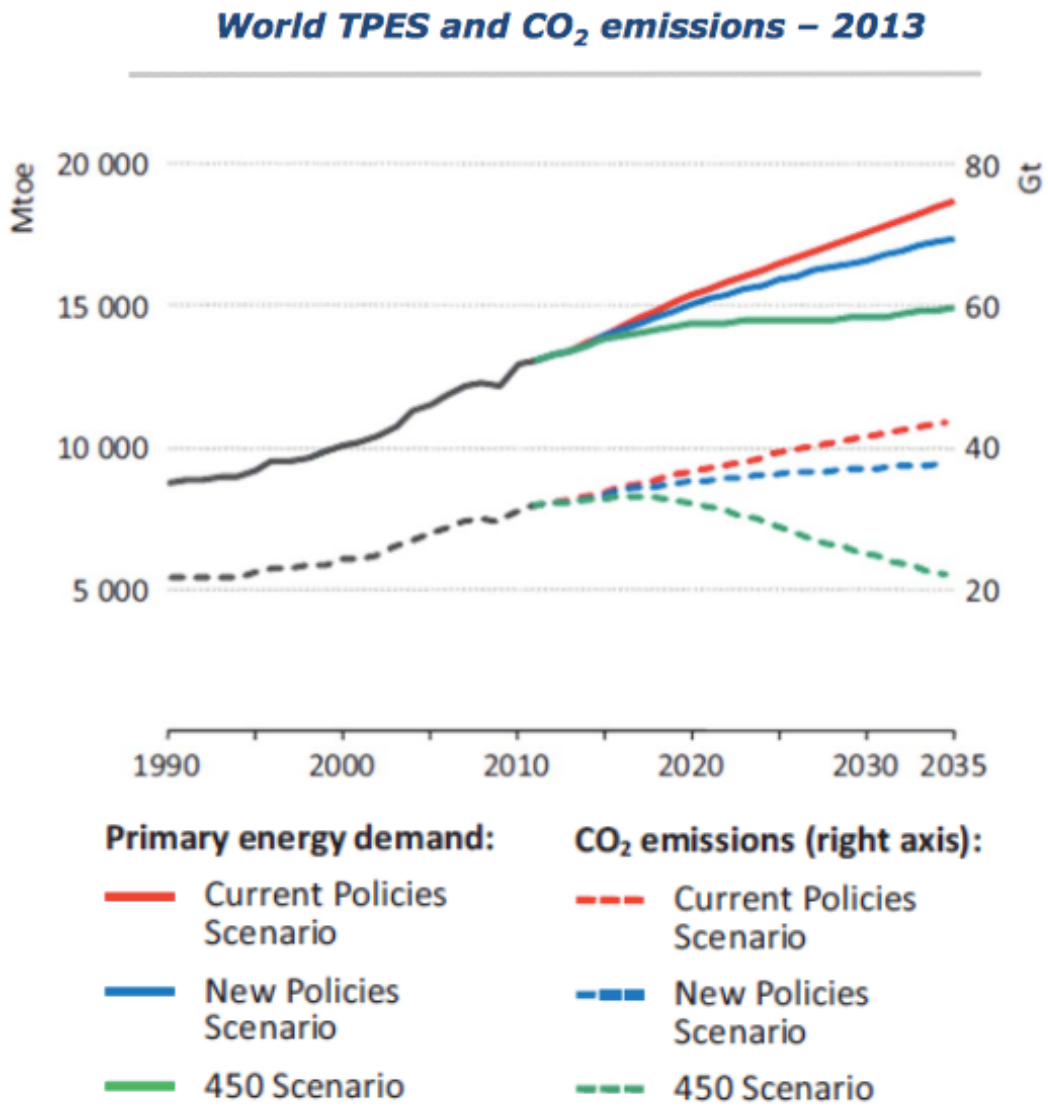
This further justifies the importance of directly focusing climate policy negotiations to target energy businesses within all GHG-contributing nations. Without a comprehensive policy at this level, governments and businesses will either engage in proactive or reactive policy measures. However, as previously seen through excess market power, if countries believe a futures market for fossil fuels will no longer exist or be as prevalent in the future, producers will produce everything they possibly can today to receive the highest amount of profit conceivable, significantly contributing to GHG concentration and leaving very little in resources for the future.

[76] Ibid.

[77] Ibid.

POLICY SCENARIOS

According to scenario data from Professor Simone Mori's Economics and Management of Energy Business course at LUISS Guido Carli, the IEA provides the baseline, optimistic, and very optimistic scenarios in such a way that is understandable, while also relatable to the IPCC data reports and UNFCCC policy negotiation processes.



(**Source**: Simone Mori, "Lecture 2: Global Energy Trends." http://docenti.luiss.it/mori/files/2014/09/2-Global-Energy-Trends-Sola-lettura.pdf, accessed March 17, 2015.)

1. Pessimistic Scenario

As previously mentioned, there has not been a lot of deliberation in climate policy over a scenario worse than the BAU scenario, which already considers an increase of average global temperature greater than two degrees. In fact, under Energy Technology Perspectives on the IEA's scenarios and projections web page, there are three degree scenarios that correspond to World Energy Outlook projection scenarios: 1) 2DS, which "describes an energy system consistent with an emissions trajectory that recent climate science research indicates would give an 80% chance of limiting average global temperature increase" to two degree celsius; 2) 4DS, which "takes into account recent pledges made by countries to limit emissions and step up efforts to improve energy efficiency" and; 3) 6DS, which "is largely an extension of current trends,"[78] where 2DS, 4DS, and 6DS correspond to the 450, NPS, and BAU World Energy Outlook climate scenarios of two degrees, four degrees, and six degrees, respectively.

An immediate scenario more pessimistic than a six degrees global average temperature increase, inherent in the BAU scenario, has briefly been explored, as climate scientists initially believed we would not dream of doing this level of damage to ourselves. According to blogger David Roberts, who spoke at TEDx Evergreen State College, if we continue on the path we are now, climate change could take on a life of its own.[79] By 2300, we could see global average temperature increase by 12 degrees celsius, resulting in half of earth's currently inhabited land to be inhabitable.[80] Taking a step outside would no longer be possible in most parts of the world; human beings would literally die of hotness.[81] Roberts poses the question, would there still be human civilization under these

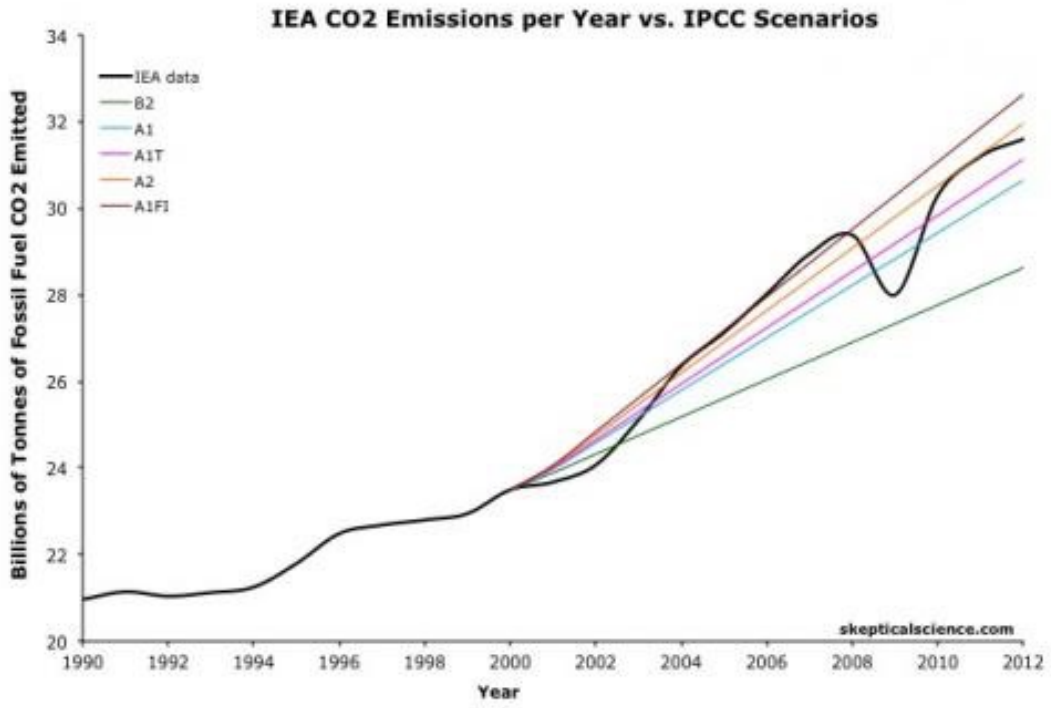
[78] International Energy Agency, "Publications: Scenarios and Projections."

[79] TEDx Talks. "Climate Change is simple: David Roberts at TEDxTheEvergreenStateCollege," YouTube, published 12 June, 2012. [https://www.youtube.com/watch?v=A7ktYbVwr90], accessed June 2015.

[80] Ibid.

[81] Ibid.

circumstances? Possibly. Regardless, civilization would be completely different to human civilization as we currently know it. Contextually, the immediate version of this scenario is often represented graphically in some models, but with key focus on the BAU, NPS and 450 scenarios. Recall the graph below, the dark maroon line, A1F1, would be considered the more pessimistic scenario than the BAU scenario.



(**Source**: Skeptical Science, "CO2 Emissions vs IPCC Scenarios," http://www.skepticalscience.com/graphics.php?g=20, accessed April 2015.)

2. Baseline Scenario: Business As Usual

According to the IEA, the Business As Usual scenario is the contextual hypothesis of continuing current trends in population, economy, technology and behaviour, including planned improvements in efficiency. In the BAU scenario, the evidence supplied in the IEA's World Energy Outlook, Key World Energy Statistics 2014 are extrapolated upon, with expectations of rising trends in average temperature and CO2 increases, even though year-to-year data may be erratic. The baseline assumes

continued rapidly growing economies, ongoing industrialization in developing countries, and increased energy efficiency in developed countries without further international climate policy cooperation (such as potential ratifications from discussions at the Conference of the Parties (COP) in Paris in 2015 later this year), but does take into account the exceptions of those policies already in advanced planning stages and/or in implementation phases.

It is true that earth climate cycles have produced varying changes in global average temperatures, typically over hundreds of thousands of years or even millions of years. In Roberts' TEDx talk, he informs us that, for the last 10,000 years on earth, the earth has been at a relatively stable temperature. By stable temperature, he means that global average temperature has varied, but has remained within a narrow band of temperature fluctuation of about plus or minus one degree celsius.[82] Earth is capable of sustaining life due to its thin atmospheric layer that traps the sun's energy, creating evaporation, photosynthesis and precipitation. Climate scientists firmly understand now that human activity can drastically change the chemical composition of this atmospheric layer, holding the sun's energy for much longer, causing changes in the biophysical systems of the earth.[83] Roberts' states that everything we know today has been built and developed within this time of relative climate stability, such as technology and fuel extraction, which has changed the chemical composition of the atmosphere within a much faster time period than natural earth climate cycles.

From the gathered evidence and information from the IEA's current trends, it is clear that without ambitious and immediate policy ratification from both developed and developing countries, the earth is on track for a six degree celsius increase in average global temperature by the year 2100. The real, inherent concern is the possibility that the BAU scenario represents an existential threat of

[82] Ibid.

[83] Ibid.

climate change becoming irreversible. Roberts simplistically explains that the earth contains positive feedback systems. For example, permafrost in Siberia contains methane, and as this permafrost melts, methane is released. As this methane is released into the atmosphere, methane causes more warming. More warming then creates more melting of the permafrost, which again produces the release of more methane. Another example is of ice cap melting; ice is white and therefore, reflects energy. However, as ice melts, it becomes dark blue, which consequently absorbs energy—sometimes referred to as the "albedo effect." As the absorption of energy occurs, the ocean heats up, which melts more ice, and creates more dark surfaces on the earth.[84]

Since the pre-industrial age, climate scientists have measured about a 0.8 degree celsius increase due to human activity from 50 to 100 years ago. "What we will see in the first half of this century is a response to what we have done 50 years ago, and what we see in the latter half of this century will be a response to the decisions we make today."[85] The danger of our decisions today could produce a scenario where the positive feedback systems take on uncontrollable momentum, and we are no longer capable of controlling our own destiny, even if we eliminate all production of emissions overnight. The impacts felt with currently rising temperatures and CO2 production in storm intensity, droughts, and heat waves will only occur more frequently and escalate in severity.

3. Optimistic Scenario: New Policy Scenario

Recall from earlier chapters, the New Policy Scenario refers to "a scenario in the World Energy Outlook that takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse-gas emissions and plans to phase out

[84] Ibid.

[85] Ibid.

fossil-energy subsidies, even if the measures to implement these commitments have yet to be identified or announced."[86]

The NPS scenario draws broad parallels between the Energy Technology Perspectives 4DS scenario, which estimates a global average temperature increase of four degrees celsius, accounting for emissions target reduction pledges and action by ratifying countries.

What does this type of increase look like? According to Roberts, in 2009, research groups in England commissioned papers to explore global average temperature increases above two degrees celsius. Specifically referring to a four degree celsius temperature increase, these papers found that, by 2100, the earth will experience the highest temperatures seen in 30 million years.[87] Sea levels may rise between three to six feet and there will most likely be long, drawn-out droughts of over 40 percent of inhabited land. This would wreak havoc in Asian, African, and Western US agriculture and food resources, producing hundreds of millions of refugees driven from homes due to floods, lack of food and resources, etc.[88] Furthermore, half of the world's known species would become extinct. In the opinion of Professor Kevin Anderson, "a four degree celsius future is incompatible with an organized global community."[89]

4. Very Optimistic Scenario: 450 Scenario

The very optimistic scenario is "a scenario presented in the World Energy Outlook that sets out an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of greenhouse gases in the atmosphere to around 450 parts per million of

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[86] International Energy Agency, "Publications: Scenarios and Projections."

[87] TEDx Talks "Climate Change is simple: David Roberts at TEDxTheEvergreenStateCollege."

[88] Ibid.

[89] Ibid.

CO2,"[90] suitably referred to as the 450 Scenario. Limiting global average temperature increase to two degrees celsius was a largely political decision, agreed upon by European climate negotiators approximately 10 years ago.[91] All countries involved in climate negotiations agreed that the resulting impacts from this point of temperature increase is what they wanted to avoid.

However, the latest climate science from the last 10 to 15 years points to the impacts from a two degree celsius increase will happen much earlier than expected; the earth's atmosphere is far more sensitive to added GHGs than initially thought.[92] This understanding has meant an increasing number of climate scientists believe that a two degree celsius increase is almost certainly too high to be safe for humanity, and too low to be possible to attain.[93] Thus, climate scientists believe the real threshold of safety should actually be at a 1.5 degree celsius average global temperature increase, though this threshold is least likely to be accomplished.

Even so, if we were to cease emission production tomorrow, it is near guaranteed that we will exceed a two degree celsius increase to approximately three degrees celsius, warranted by the momentum from previous emissions remaining in the atmosphere. To slow temperature increase and limit carbon emissions, it will take a serious level of global coordination and ambition. Unfortunately, with over 20 years of debate and discussion, there has been very little cooperative action, which does not bode well for future climate policy.

According to the IEA, to stabilize temperature, global climate emissions must peak within five to ten years, and decline every year thereafter. This means that the level of GHG production and

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[90] International Energy Agency, "Publications: Scenarios and Projections."

[91] TEDx Talks "Climate Change is simple: David Roberts at TEDxTheEvergreenStateCollege."

[92] Ibid.

[93] Ibid.

temperature increase must reach the highest possible level by at most 2025, and must experience rapidly decreasing levels each superseding year. With every year that countries and international policy is delayed, $500 billion is added to the amount of investment required to tackle and manage climate change[94].

[94] Ibid.

RELEVANT AND IMMEDIATE RISK

Immediate risks are not necessarily those that happen within a month, or within a year, or even within a decade; short-term risks are risks that could occur at the very end of the Baby Boomer Generation (population born in 1945 to 1965) or Generation X (population born in 1966 to 1976), but certainly within Generation Y and Z's lives (population born in 1977 to 1994 and 1995 to 2012 respectively). Approximately 50 to 70 years from now, the risks the world's population could face directly stem from the decisions made today by businesses, nations, and international coordination. From food shortages to increased frequency in natural disasters and unpredictable Black Swan events, there are opportunities to mitigate these relevant and immediate risks, lessening the impact climate change and global chaos could have on us.

Fate of Farming

In Roberts' TEDx talk, he makes it quite clear that these small global average temperature increases could drastically affect the agricultural industry in areas in Asia, Africa, and Western North America. In fact, the American state of California had approved emergency drought procedures in May, earlier this year. The regulations required cities and water agencies to reduce consumption and use of water from anywhere between 8 and 36 percent.[95] Urban areas have been required to cut water usage by 25 percent statewide.

According to USA Today, this May has been the first time California has called for such drastic measures in mandatory reduction of water use. In these desperate times, the state water board has also been given actionable authority for the first time to issue fines of up to $10,000 USD, either against cities or water districts that stray from emergency regulations.[96] Water agencies have

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[95] Ian James, "California board approves emergency water rules," USA Today, May 6, 2015. [http://www.usatoday.com/story/news/nation/2015/05/05/california-water-restrictions-missed-targets/26928275/], accessed June 2015.

[96] Ibid.

discretion in how they believe is best to achieve the regulations' targets, such as the discriminatory power over commercial, industrial or domestic cutbacks in water consumption through price-changing methods and watering-time approaches.[97] For now, regulations exclude the majority of the farms in California. However, as "the snowpack in the Sierra Nevada has shrunk to a record low, groundwater levels have plummeted across much of California, and in some areas of the Central Valley, the wells of hundreds of families have run dry,"[98] farming could very well succumb to these severe restrictions.

However, these drought conditions have not appeared out of the blue. For the last four years, California has experienced extremely dry conditions that are only getting worse. Forest lands across the state of California are in dire danger, as over the past few months, researches estimate that at least 12.5 million trees have been killed off due to the drought.[99] Scientists expect increases in this number as summer approaches, and conditions intensify. Jeffrey Moore, a biologist interviewed in the LA Times, used a digital aerial sketch-mapping system to survey areas in the Cleveland, San Bernardino, Angeles, and Los Padres national forests. Other prominent parks, such as Pinnacles National Park, Sierra and Sequoia national forests, as well as Yosemite National Park were also surveyed; about 990,000 acres of dead trees were found, with double the tree deaths in the Stanislaus area since July.[100]

Trees are an incredibly important part of earth's global ecosystems. Just as the human population requires oxygen to survive, trees require carbon dioxide. When humans inhale oxygen, a chemical

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[97] Ibid.

[98] Ibid.

[99] Veronica Rocha and Hailey Branson-Potts "Drought Kills 12 Million Trees In California's National Forests," LA Times, May 5, 2015. [http://www.latimes.com/local/lanow/la-me-ln-trees-dying-california-drought-20150505-story.html], accessed June 2015.

[100] Ibid.

reaction occurs in our lungs that results in a higher concentration of carbon dioxide upon exhaling. Prior to the industrialization age, humans' production of carbon dioxide very barely reached the carrying capacity of forests' ability in reabsorbing this gas. Today, the amount of carbon dioxide and deforestation that has occurred has created a situation where forests are no longer able to reabsorb the amounts of carbon dioxide present in the atmosphere. This situation will be made ever more alarming with mass acres of forests, such as the issue in California, dying out due to lack of water in drought conditions.

Furthermore, weakened trees are being polished off by bark beetles, which are "tiny brown insects that thrive in dry conditions, chewing away at pines and making them brittle."[101] Bark beetle infestations consumed huge portions of mountainsides in 2003, and are again after dehydrated trees that can no longer produce the resin needed as a natural defence to fend off the colonization of these insects. All of these circumstances will lead to extreme fire hazards in the state's forests if temperatures continue to rise, and water remains scarce, which could also seriously affect farming fields. Fire fighters have had to "augment their staffing, because any small fire [could] explode into a devastating blaze."[102]

Such drastic situations will not only be frequented in California; in the next 50 to 70 years, globally significant forests will realize acres of wiped out, devastated tree lines and dried out farmlands, allowing population growth of infestations of all sorts of insects that are capable of survival in this climate.

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[101] Ibid.

[102] Ibid.

Natural Disasters

The bottom line is that natural disasters are occurring nearly five times as often as the 1970's.[103] However, politicians have to not only account for the severity of these disasters, but also analyze the inherent costs. Countries that possess the national resources to effectively provide disaster relief to their citizens in such situations have usually accounted for these possibilities, and put aside funding. It becomes more complicated when developing countries, that are not educated about the science behind human-induced climate change, are also not equipped to handle such disaster situations. Countries such as these have minimal national resources to provide disaster relief to its citizens, and depend on developed countries and their organizations to provide aid.

According to the World Meteorological Organization, "the full value of damage and loss data is best realized when such information is combined with meteorological, hydrological and other environmental data. By describing the location, severity or frequency of hazards, these data make it possible to analyze the historical and geographical patterns of cause and effect."[104] Despite this, natural disaster cost can be difficult to estimate. For example, if a tropical cyclone produces storm surges and ensuing flooding, landslides, and wind destruction, damages would allocate to both the coast and inland.[105] As the oceans warm, the warming water fuels the formation of tropical storms over these bodies of water and creates more destructive, higher intensity storms. Greater numbers of cases of Category 4 and 5 hurricanes and storms, and increased droughts and wildfires have been attributed to higher temperatures.[106]

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[103] Suzanne Goldenberg, "Eight ways climate change is making the world more dangerous," The Guardian, July 14, 2014. [http://www.theguardian.com/environment/blog/2014/jul/14/8-charts-climate-change-world-more-dangerous], accessed June 2015.

[104] World Meteorological Organization, "Atlas of Mortality and Economic Losses From Weather, Climate and Water Extremes (1970-2012)," (PDF file), downloaded from WMO Website, [http://www.wmo.int/pages/prog/drr/transfer/2014.06.12-WMO1123_Atlas_120614.pdf], accessed June 2, 2015.

[105] Ibid.

[106] National Geographic, "Hurricanes, Engines of Destruction," http://environment.nationalgeographic.com/environment/natural-disasters/hurricane-profile/, accessed June 2015.

Hurricanes are a type of tropical storm that relies upon heat from warm, moist ocean air and releases it through condensation of water vapour in thunderstorms.[107] Similarly, supercell thunderstorms are formed from the heating of the air just above earth's surface. As this warming air rises and cooler air above it sinks, an unstable body of warm air is created, resulting in updrafts of more warm, damp air.[108] Tornadoes often spawn from supercell storms; when the storm begins rotating, it creates a funnel cloud that produces a faster spinning, thinner body of air, which eventually reaches the surface of the earth due to the presence of rain and hail.[109] From the formation of these storms, we are able to deduct that increasing temperatures resulting from GHG emission production, particularly in the earth's oceans, severely increases the risk and costs of frequency and intensity of storms.

Furthermore, "even with storms of the same intensity, future hurricanes will cause more damage as higher sea levels exacerbate storm surges, flooding, and erosion."[110] Unless otherwise stated, the following facts and figures were written and published by Suzanne Goldenberg in The Guardian, referencing the World Meteorological Organization report.[111]

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[107] Ibid.

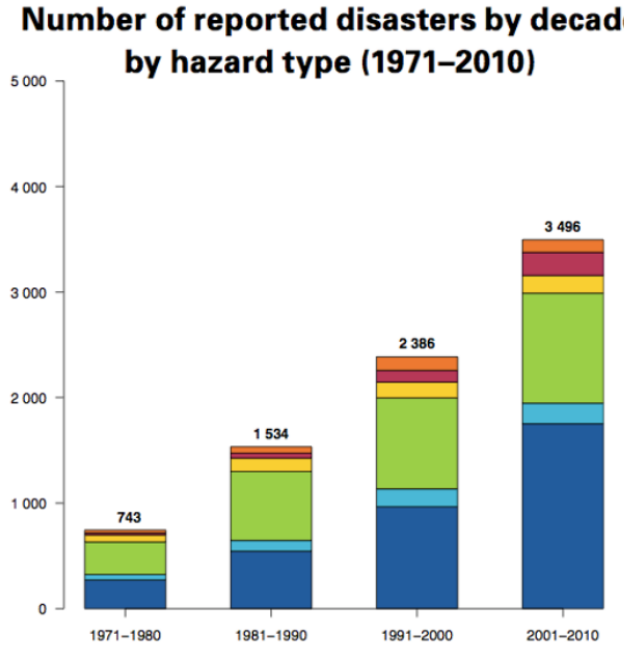
[108] Centre For Science Education, "Kids Crossing: How Do Thunderstorms Form?," https://eo.ucar.edu/kids/dangerwx/tstorm4.htm, accessed June 2015.

[109] Centre For Science Education, "Kids Crossing: How Do Tornadoes Form?," https://eo.ucar.edu/kids/dangerwx/tornado3.htm accessed June 2015.

[110] Natural Resources Defense Council, "The Consequences of Global Warming On Weather Patterns," http://www.nrdc.org/globalwarming/fcons/fcons1.asp, accessed June 2015.

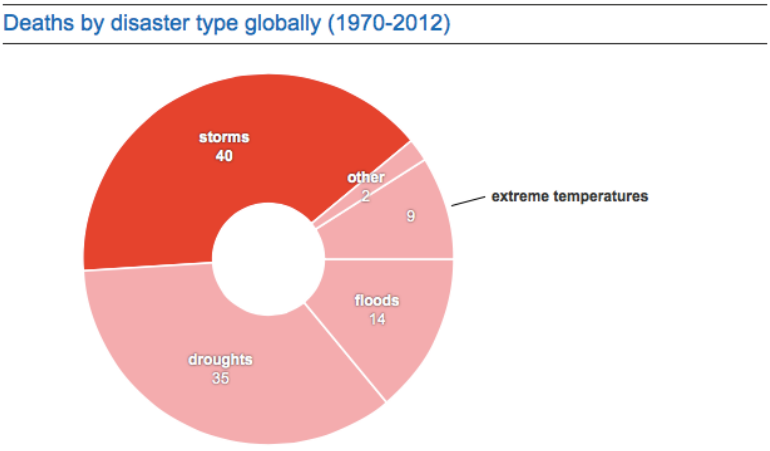
[111] Suzanne Goldenberg, "Eight ways climate change is making the world more dangerous," The Guardian.

According to the article, flooding and storms accounted for approximately 80 percent of recorded disasters in the last decade, where dark blue represents floods and green represents storms.[112]



Key: Dark blue = floods. Light blue = mass movement wet. Green = storms. Yellow = drought. Magenta = extreme temperature. Orange = Wildfires Photograph: /WMO

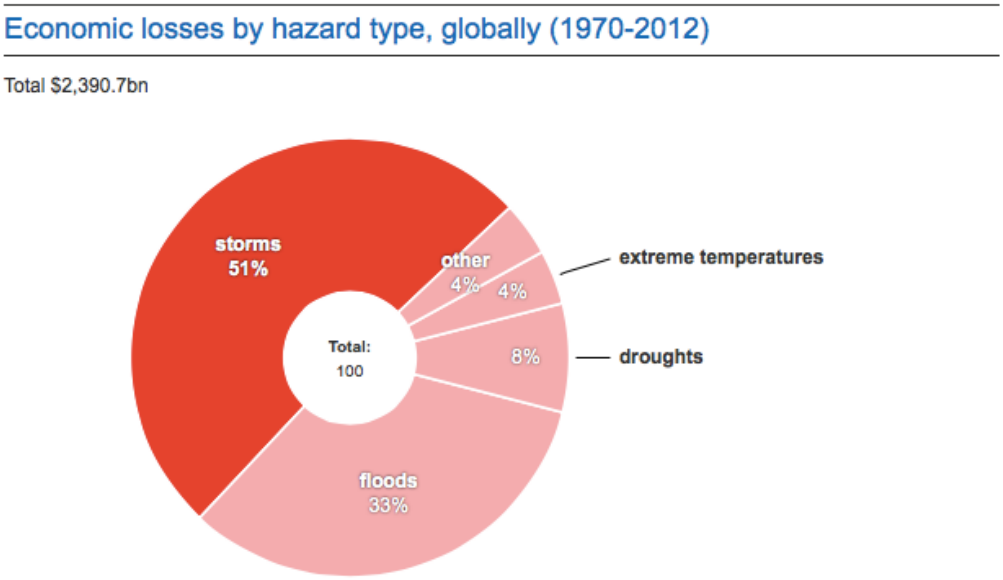
Storms were the largest threats, responsible for 1.45 million of 1.94 million disaster deaths.[113]



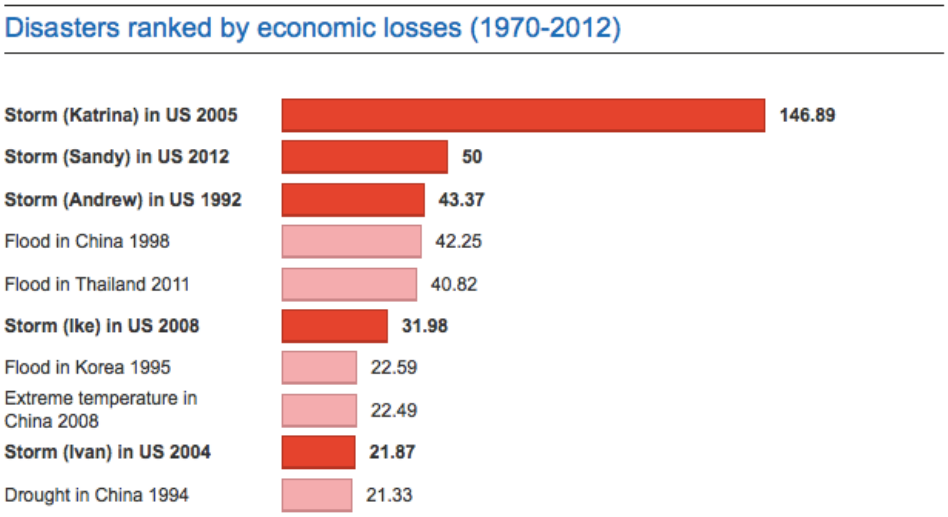
[112] Ibid.

[113] Ibid.

Devastating storms such as Super Sandy and Hurricane Katrina accounted for $196.9 billion USD of the $2390.7 billion USD allocated to cost of disasters in the last 40 years.[114]



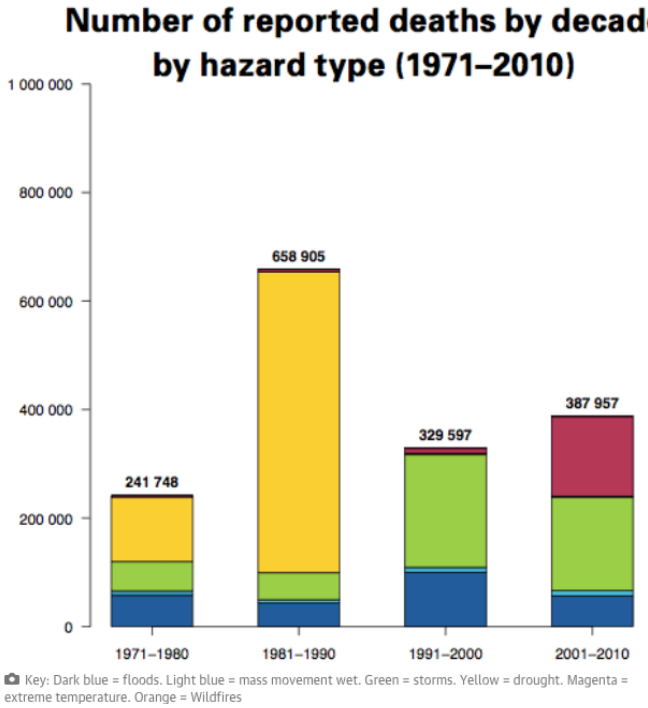
In general, the cost of disasters increased by an estimated 5.5 times to $864 billion USD with the last decade.[115]



[114] Ibid.

[115] Ibid.

By 2010, heat waves were among the leading causes of natural disaster deaths, shown in magenta to represent extreme temperature.[116]



Fracking

Hydraulic fracturing, or fracking, is a type of "drilling process that injects millions of gallons of water, sand, and chemicals under high pressure into a well, cracking the rock…to release natural gas and oil."[117] This drilling method is especially prevalent in the American state of Texas, where latest increases in tremors have been reported. Recently, the disposal of drilling wastewater, though believed to be the safest and most cost-efficient approach, has finally been scientifically linked to the growing number and strength of earthquakes.[118] Therefore, the primary cause of the earthquakes are not a result of the actual drilling process, but result from the disposal of drilling waste in concrete-encased waste wells thousands of feet underground.

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[116] Ibid.

[117] State Impact, "How Oil and Gas Disposal Wells Can Cause Earthquakes," http://stateimpact.npr.org/texas/tag/earthquake/, accessed April 2015.

[118] Ibid.

According to Dr. William Ellsworth of the Earthquake Science Centre of the US Geological Survey, researchers found decades ago that they could control earthquakes by injecting liquid into the ground. Thus, when liquid is injected into fault lines, faults can slip, creating earthquakes. In 2008, two disposal wells were built near the DFW airport in Texas, where scientists found these wells produced earthquakes a mere seven weeks later.[119] From the study, scientists stated that over two years, the earthquakes were magnitudes 3.0 and below. However, since then, several earthquakes have exceeded a 3.0 magnitude, with some as high as 3.5.[120] Although these earthquakes have not yet caused any notable damage, this trend of man-induced activity is worrisome. For locals and those in the natural gas business, unfortunately, their main concern is damage to drilling infrastructure and well stability. The real issue should be, if these earthquakes get any bigger as increased stress and pressure from the disposal wells become too much for the earth's crust to handle, Texas could experience a large, disastrous earthquake, costing the government hundreds of millions of dollars of relief funding.

US Geological Survey's Earthquake Science Centre's Art McGarr has researched the effects disposal wells could have on the strength of earthquakes; the question is "as wastewater stays in the disposal wells longer and more and more fluids are added, will the quakes become stronger?"[121] According to McGarr, they will, which means wells that have been in use longer and have larger volumes of disposal wastewater in the wells could produce stronger earthquakes than relatively younger wells. Furthermore, policymakers in Texas suggest to follow Ohio's requirement for detailed analyses of geological conditions before authorizing new disposal wells. However, more

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[119] Ibid.

[120] Ibid.

[121] Ibid.

wells, even a decreased number of new disposal wells, will continue to produce unexpected seismic activity. How many well-induced earthquakes need to happen in order for just one to produce enough damage to cost the United States billions of dollars? Understandably, policymakers can only expect levels of mitigation; they could not expect Texas drilling processes to cease immediately, especially when the state heavily relies on this industry. However, policymakers should create plans to phase out these kinds of drilling processes to ambitiously mitigate the potential risks associated with maintaining the current levels of fracking and disposal of drilling wastewater. One thing is for certain: if these activities continue, increased frequency and intensity of seismic risk will persist.

Black Swan Theory

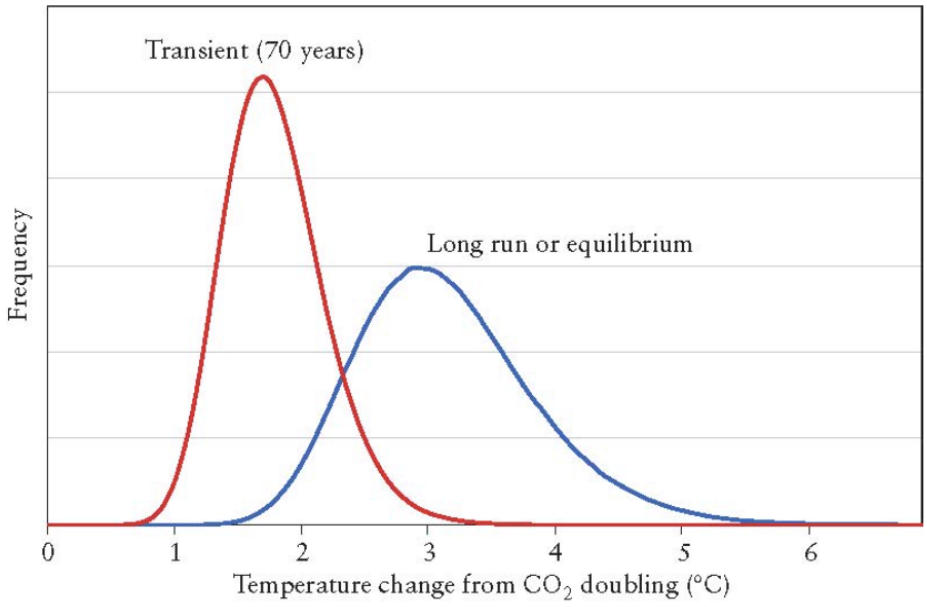
The Black Swan Theory describes events that are typically random and occur unexpectedly, but have a major effect. Such events include the explosion of the Chernobyl Nuclear Power Plant in 1986, the September 11th terrorist attack on New York City, or the recent Ebola outbreak in Africa. Although Black Swan events may or may not be directly correlated or caused by progressively worrisome temperature increases, if temperatures were to increase to unprecedented levels, chaos would be imminent. Whatever global cooperation left would rapidly diminish as people flee their homes due to increases in war over food and habitable land, floods, and drought. It is important to imagine worst-case scenarios and keep such events within sightline so as to be capable of mitigation if such situations were to arise.

RELEVANT AND LONG-TERM RISK

Long-term risks are those that are estimated to occur far into the future; the population today will never experience the impacts of these risks within their lifetime. Approximately 150 years from now and beyond, if minimal action is taken to prevent imminent risk, future world population will undoubtedly face conditions that would become unliveable. With a loss of control over our earth systems, humankind would most likely cease to exist in the long run. From coral bleaching to the release of methane in Arctic permafrost, the temperature changes are sure to globally affect all forms of human and animal life, including those in the oceans. If a blatant disregard and lack of climate decisions for impending risks exists, there will probably be no opportunity for mitigation once climate change takes on a life of its own.

Transient versus Long Run Equilibrium

It is important to note and to understand the differences in transient (short run) and long run equilibrium temperature changes.



(**Source**: William Nordhaus, "The Climate Casino: Risk Uncertainty, and Economics for a Warming World," http://yalebooks.com/pdf/Nordhaus_Slides.pdf], accessed May 2015.)

In William Nordhaus's Climate Casino, temperature response models from the IPCC's Fourth Assessment Report is included to graphically explain the smoothing of long run distributions of temperature increases.[122] The red graph estimates a transient response to temperature increases after 70 years, and exhibits an average temperature increase of 1.8 degrees celsius. The blue graph to the right estimates the long run, or equilibrium, effect with an average temperature increase of just over three degrees celsius.

By the year 2050, the IPCC models projects the average temperature increase from the red graph, which is two times preindustrial levels, will be realized.[123] The IPCC models the equilibrium response, the blue graph, to be nearly double the average temperature increase of the transient response. The difference between these two responses is the amount of time it takes to experience these temperature changes. This is an incredibly important distinguishing factor to make. The long run warming of the deep oceans is gradual, occurring over many, many years of temperature increases. In the transient response, adverse warming effects may not be easy to see. However, over longer periods of time, the effects of deep ocean warming can be noted. Nevertheless, at this point, it will be too late to reverse the effects of warming of the deep oceans, as the inertia from 150 years or more of temperature increases is too great to stop.

Though transient responses may be unlikely to be able to curtail, equilibrium responses may provide a chance to stop, or at the very least, significantly reduce the inertia of the response. As stated in the Climate Casino, "if today's rising concentrations of CO2 are reversed relatively quickly, then temperature will also come down because the deep oceans have not yet warmed."[124]

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[122] Nordhaus, *The Climate Casino*, pp. 42-43.

[123] Ibid., p. 43.

[124] Ibid., p. 44.

Arctic Methane

There is some debate over whether the release of arctic methane from permafrost and the arctic oceans will be catastrophic, or whether it will be manageable by natural processes. Some scientists believe that methane deposits, such as sites off the Svalbard archipelago, are being destabilized by specialized bacteria that consume methane.[125] However, most scientists estimate that the abrupt release of millions of tonnes worth of methane frozen in the Arctic permafrost, which extends from the mainland to the shallow seas of the East Siberian Arctic Shelf, will propel climate change to accelerate at rates beyond control.

A recent study published in 2010 estimated that Arctic methane emissions were in the range of 8 million tons a year, but the latest explorations indicate these values are huge underestimates.[126] Release of even fractions of the overall methane stores in this shelf could trigger sudden climate warming.[127]

Igor Semiletov of the International Arctic Research Centre at the University of Alaska Fairbanks stated, "in a very small area, less than 10,000 square miles, we have counted more than 100 fountains, or torch-like structures, bubbling through the water column and injected directly into the atmosphere from the seabed," where some columns were "a kilometre or more wide and the emissions went directly into the atmosphere - the concentration was a hundred times higher than normal."[128]

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[125] Arctic Methane: Is Catastrophe Imminent?, 20 Decemeber, 2011, NY Times, http://green.blogs.nytimes.com/2011/12/20/arctic-methane-is-catastrophe-imminent/?_r=0, accessed April 16, 2015.

[126] Vast methane 'plumes' seen in Artist ocean as sea ice retreats, 13 December, 2011, The Independent, http://www.independent.co.uk/news/science/vast-methane-plumes-seen-in-arctic-ocean-as-sea-ice-retreats-6276278.html, accessed on April 16, 2015.

[127] National Science Foundation, "Methane Releases From Arctic Shelf May Be Much Larger and Faster Than Anticipated," http://www.nsf.gov/news/news_summ.jsp?cntn_id=116532, accessed April 2015.

[128] "Vast methane 'plumes' seen in Arctic ocean", The Independent.

Concentrations of methane have increased two to three times in the past two centuries to levels that have never happened in the history of the earth, from 0.7 ppm (parts per million) to 1.7 ppm in most parts of the world and 1.9 ppm in the Arctic.[129] The risk of rapid release of methane gas from these stores in the Arctic regions is uncertain as to how fast the methane will end up in the atmosphere; whether a short term risk or a long term risk, the speed at which methane is being released is occurring over a relatively short period of time. It will be further provoked by the earth's positive feedback cycles Roberts has referred to in his TEDx presentation. While the warming of the oceans and the earth is a very frightening risk, sea level rise will be the least of concern if methane in the earth's atmosphere intensifies so far beyond mitigation and restraint.

Coral Bleaching

As stated by the National Oceanic and Atmospheric Administration, coral bleaching occurs when "corals are stressed by changes in conditions such as temperature, light, or nutrients, [and] expel the symbiotic algae living in their tissues, causing them to turn completely white."[130] Coral itself is usually a translucent colour, and only gains its colour from its symbiotic relationship with algae. When the environment in which corals live becomes stressed, algae will depart from this relationship of living in the coral's tissue. Without the algae, coral returns to its original colour, where it becomes subject to increased threats of stress and mortality.

Coral bleaching can be caused my changes in ocean temperatures, overexposure to sunlight, pollution or acidification of oceans, and extreme low tides. Other impacts, such as overexploitation, overfishing, increased sedimentation, increases in violent storms, and flooding, are also stress-

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[129] Ibid.

[130] National Oceanic and Atmospheric Administration, "What is coral bleaching?," http://oceanservice.noaa.gov/facts/coral_bleach.html, accessed April 2015.

related events causing coral bleaching. Changes in ocean temperatures, specifically increases in temperatures, are the notorious leading cause of coral bleaching and coral death. Sometimes, if the stressful environment is not too severe, or only lasts a short time, the coral is able to recover.

At first glance, coral bleaching may not seem like a big issue; coral reefs only cover less than one percent of Earth's underwater ecosystems.[131] Regardless, coral reefs support the lives of people in various industries, such as fishing and marine tourism. According to the Jakarta Post, an Indonesian newspaper, approximately $1.22 million USD is attributable to the fishing sector, and $212 million USD is attributable to the marine tourism sector in areas such as Indonesia.[132] Furthermore, coral reefs shelter about 25 percent of marine species, protect shorelines from storm waves, and are being used as research for undiscovered medical breakthroughs.[133]

Why, then, is coral bleaching a long term risk and not a short term risk? The importance of coral bleaching far exceeds the actual bleaching process and subsequent losses in tourism dollars. The long run effects of coral bleaching assesses how prolonged stresses to these marine ecosystems will affect the vast majority of the animal kingdom. Thus, the abundance of coral is incredibly important to human survival as well.

For hundreds of millions of years, species of plants and animals have died off at approximately the same rate as new plant and animal species have come about. This is referred to as the "background rate." These cycles occur over millions of years, with the elimination of these species due to various natural causes such as volcanic eruptions, or asteroid or comet collisions; it is the natural cycle of

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[131] The Nature Conservancy, "Oceans and Coasts, Coral Bleaching: What You Need To Know," http://www.nature.org/ourinitiatives/urgentissues/coralreefs/coral-reefs-coral-bleaching-what-you-need-to-know.xml, accessed June 2015.

[132] Desy Nurhayati, "Coral damage affects humans: Experts," The Jakarta Post, August 5, 2011. [http://www.thejakartapost.com/news/2011/08/05/coral-damage-affects-humans-experts.html#sthash.5Mkj2lIa.dpuf], accessed June 2015.

[133] The Nature Conservancy, "Oceans and Coasts, Coral Bleaching: What You Need To Know."

the earth. Nevertheless, when the background rate is no longer in balance, where extinctions rapidly increase over short periods of time, mass extinctions may occur. Scientists today are concerned for the rate at which species are becoming extinct, as "species are dying off thousands of times faster than the normal background rate."[134] A number of biologists and scientists are convinced we are in the midst of a sixth human-induced mass extinction, with the last mass extinction ending the age of the dinosaurs 65 million years ago.[135]

A lists of at-risk species, referred to as the "Red List" is kept by the World Conservation Union, with approximately over 16,000 species at risk of extinction. The Red List consists of nearly half of all primates, 12 percent of the world's bird species, a third of amphibian species, and 20 percent of the 6,000 mammal species.[136] A collapse of biodiversity of this magnitude could result in a catastrophic collapse of all species, including humans, as biodiversity is needed to promote healthy organisms that can protect themselves against disease and other threats, while also enabling development of new species. Stable and productive ecosystems are able to—and must—provide "ecosystem services" such as regulating global climate, purifying air and water, forming and enriching soil later used in farming, eliminating toxic substances, pollinating crops, and preventing erosion.[137] Ecosystems that are failing can no longer provide these ecosystem services, and the interconnected relationships that rely on these services will soon collapse as well.

"Hot spots" are particularly important ecosystems that contain the most varying and largest numbers of biological diversity, and are also the systems in the gravest danger of extinction.[138]

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[134] Constitutional Rights Foundation, "Are We Headed for a 'Sixth Mass Extinction?," http://www.crf-usa.org/bill-of-rights-in-action/bria-25-1-are-we-headed-for-a-sixth-mass-extinction, accessed April 2015.

[135] Ibid.

[136] Ibid.

[137] Ibid.

[138] Ibid.

Coral reefs are classified as such systems. In Southeast Asia, there is a reef called the Coral Triangle, which covers an area equivalent to half the size of the US, and is one of the world's largest at-risk marine hot spots. This reef serves as a feeding area for over 3,000 types of fish, whales, sea turtles, and other marine species.[139]

Furthermore, areas in the oceans, referred to as dead zones, have been increasing in numbers. Dead zone is a colloquial term for hypoxia, a level of such reduced oxygen in the water, no life can survive there. The National Oceanic and Atmospheric Administration has stated that hypoxic regions are a result of "many physical, chemical, and biological factors that combine to create dead zones, but nutrient pollution is the primary cause of those zones created by humans."[140] Excess nutrients, or nutrient pollution, is a consequence of run off of wastewater and other pollutants into bodies of water that can cause algae blooms (overgrowth of algae), which then sinks and decomposes in the water, consuming the oxygen supply needed to sustain marine life. The second largest dead zone in the world is in the northern Gulf of Mexico. Dead zones have also increased due to the warming of waters. Since the 1960's, dead zones have doubled in frequency around the world, where researchers have found and evaluated more than 400 dead zones.[141] Approximately 94 percent of these zones will experience temperature increases; below the graph shows the expected temperature increases by the end of the century in varying colours of extremity, as well as the documented dead zones in shown as white dots.

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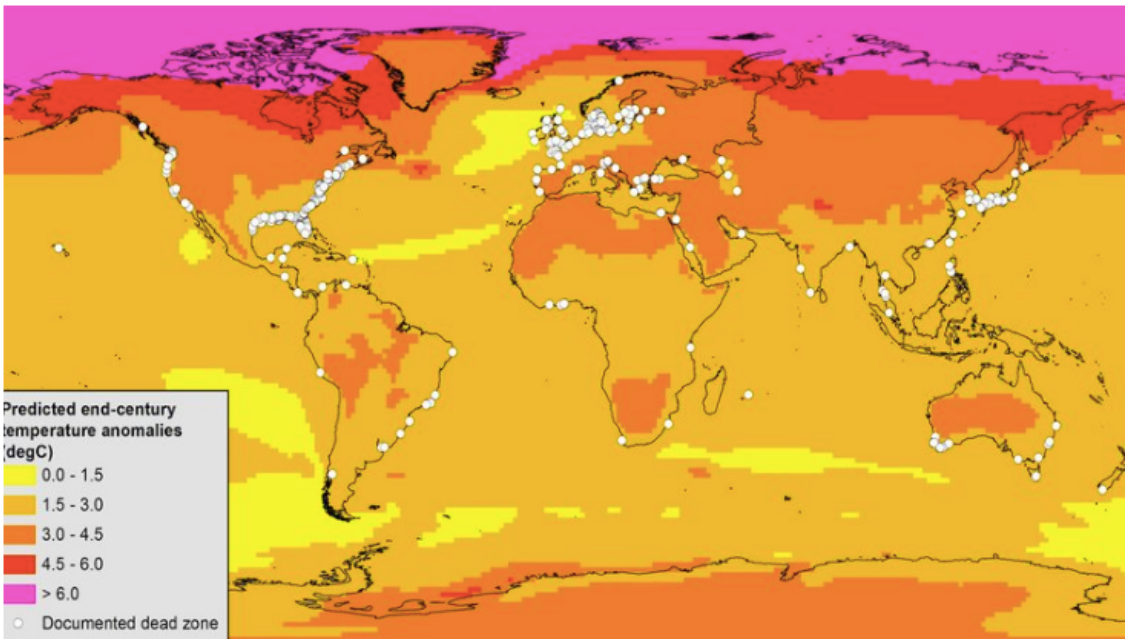
[139] Ibid.

[140] National Oceanic and Atmospheric Administration, "What is a dead zone?," http://oceanservice.noaa.gov/facts/deadzone.html, accessed April 2015.

[141] Sarah Zielinski, "Ocean Dead Zones Are Getting Worse Globally Due To Climate Change," smithsonian.com, November 10, 2014 [http://www.smithsonianmag.com/science-nature/ocean-dead-zones-are-getting-worse-globally-due-climate-change-180953282/?no-ist], accessed April 2015.



(**Source**: Sarah Zielinski, "Ocean Dead Zones Are Getting Worse Globally Due To Climate Change," http://www.smithsonianmag.com/science-nature/ocean-dead-zones-are-getting-worse-globally-due-climate-change-180953282/?no-ist, accessed April 2015.)

Warmer air due to climate warming means that the surface of the oceans and other bodies of water will heat up, causing a higher level of buoyancy, increasing the risk that the surface will not mix with colder, heavier layers underneath. The colder water below is where hypoxia is generated, and without mixing, development into dead zones is most probable.[142] Already, warmer waters are unable to hold as much dissolved oxygen, and thus, for marine species such as crab and fish that require more oxygen to survive with temperature increases, ecosystems could be driven to exhaustion.

Climate change has largely spurred the expansion of dead zones, and will likely continue contribution to the spread of dead zones over the following decades by century-end. The process of extinction is a long, drawn-out process and takes many years. However, with the rates at which

[142] Ibid.

coral bleaching is occurring, and the rates of extinction of many species on the Red List, without actionable mitigation, total mass extinction is a very real possibility in the long run.

Fortunately, by reducing nutrient pollution and changing consumption habits, dead zones can be mitigated, and thus, the impacted ecosystems can be given the opportunity to thrive again.

RECOMMENDATIONS

Climate change is real; climate change is upon us. Climate change is not something that we can turn on and off, or ignore. Policymakers, specifically those involved in the COP discussions and subsequent treaty formulations, are hard at work to try to create an environment of cooperation and ambition for countries to *want* to slow the effects of global warming. There are specific carbon pricing mechanisms that can be relatively easy to implement with regards to policy, and have been successfully implemented in parts of the world. However, these mechanisms must be globally acted upon, somewhat in accordance to the honour system and good faith. Furthermore, it is not enough to hold in place carbon pricing policies; subsidies should be rewarded, not to the businesses who can produce the most profit without consideration of environmental effects, but those companies who act and are governed responsibly with respect to the environment.

In addition, consumption habits must be altered to allow for these policy changes to be truly effective. Incentives at a personal level to help motivate water conservation, recycling, and reduced energy consumption should be governed at municipal levels.

To ensure total and complete compliance, international policymakers should ensure that the global sum of emissions each year, from all countries, does not exceed the amount required to decrease CO2 production, and consequently, temperature increases. This will allow global average temperature the opportunity to come down to levels that are still high, but progressively manageable.

Carbon Pricing

Carbon pricing mechanisms come in a two different forms; emissions taxation and emissions trading. Carbon pricing mechanisms are usually first created as policies, and then adopted at micro and macroeconomic levels.

Emissions trading, or commonly referred to as cap and trade, is a famously successful carbon pricing mechanism, where a country is authorized a given carbon limit that the country is permitted to emit (includes both CO2 and other GHGs). The country can then issue emissions allowances to carbon-emitting firms, depending on the industry. The allowances are in the form of electronic certificates that "contain complex regulatory requirements, but this gives the basic idea that emissions allowances are ownership rights that can be bought and sold like cars and houses."[143] The activity of being able to buy and sell emissions allowances creates a kind of market for firms to trade on, where firms looking to sell emissions certificates would seek the highest bidders, and firms looking to buy emissions certificates would seek the lowest offers. When a bid and offer agreeably match, a transfer takes place. This cap and trade method is a proven process that has been used by the Kyoto Protocol GHG emissions plan and by the European Union's CO2 Emissions Trading Scheme to meet emissions targets and reduce pollution. Cap and trade is successful in that this mechanism creates the most economic value out of limited emissions; when emissions are capped below the unregulated market level, emissions become a scarce resource.[144] Recall from microeconomics that when a shock to supply and demand occurs like this, the price of emissions increases. In a cap and trade market, the market price of CO2 indirectly accomplishes a positive

[143] Nordhaus, *The Climate Casino*, p. 234.

[144] Ibid., p. 235.

price for carbon, rather than zero, without the need for governments to micromanage its national firms.

While the cap and trade mechanism limits quantity of CO2 emissions, the emissions tax mechanism taxes the quantity; the end result is the same. However, with emission taxes, the government directly attributes taxes relating to the combustion of fossil fuels, producing carbon dioxide that eventually enters the atmosphere.[145] Both mechanisms are meant to deter use and production of carbon-based fuels, but it is up to the governments on the rigidity and governance of the policies in place.

Subsidies

An alternative to carbon pricing mechanisms is the subsidizing of "green" technologies, including "green" energies and "green jobs." Creating fiscal incentives to lower cost and/or increase use of renewable energy technologies is a method of promoting sustainability, negating backlash from people and companies who are not fond of the idea of an additional taxation system behind emissions tax. Particularly focusing attention to the research and development sectors that are attempting to create and advance low-carbon technologies, governments should inspire a transition from a carbon-based world to a low-carbon based world by facilitating financial encouragement in the form of subsidies.

Nevertheless, subsidies could pose some problems; often, it can be difficult to determine which activities are actually considered "green," and of those that are, which "green" activities should be subsidized, and which should not. An example given in the Climate Casino makes reference to the subsidizing of hybrid cars to encourage people's purchasing decisions when in the market for

[145] Ibid., p. 236.

buying a car, and not subsidizing biking.[146] Governments are simply not able to subsidize all low-carbon activities, and thus, must identify and decide the low-carbon activities that are most in need of government subsidy. Furthermore, subsidies do not always possess the same effectiveness across all low-carbon activities, creating inefficiencies.

Therefore, using a subsidizing incentive policy in combination with the other two proven carbon pricing mechanisms would be the best possible chance of drastically improving the risk of continued CO2 production and inherent temperature increases.

Personal Incentives

All the effort placed into the aforementioned policy mechanisms may be for nought if consumption habits at a personal level persevere. Thus, it should be up to a cooperative policy between governments and their national firms to promote individual behavioural change in consumption habits. Some measures have recently been put in place in some countries to deter families and individuals from accidentally leaving lights on in their homes, buying disposable plastic water bottles, or excessively driving around town. Most of these situations contain a related marginal carbon cost resulting in monetary penalties, which alters people's daily behaviour.

Unfortunately, there are far too many commodities and services that are not priced with a related carbon cost; buying imported fruits and vegetables, clothes manufactured overseas, etc. Internationally, if all governments placed carbon costs on all goods and services, there would be a much clearer picture of which goods and services are better to buy than others. This type of pricing would vary country to country, but would reflect the true cost of producing such goods.

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[146] Ibid., p. 266.

I would rather lose in a cause that will some day win, than win in a cause that will some day lose!

- Woodrow Wilson

CONCLUSION

For all we know, the amount of effort countries and policymakers have placed into creating an international, cooperative climate policy may already be for nought. However, the growing interest in discussions at COP each year, rapid technological advancements in renewable energy technologies, and successful implementations of carbon pricing policy mechanisms breeds hope that the world of tomorrow will change for the better.

Traditionally, climate policy negotiations resulted in top-down policy approaches that attempted to reach unrealistic emissions targets, and were not favourable to ratifying countries and their domestic firms. The Kyoto Protocol was the epitome of this issue. The lack of progressive outcomes from the ratifying countries of the Kyoto Protocol has led to the goal of a more detailed climate debate, with more and more countries involved in the planning and discussion of a successor to Kyoto.

The findings of the research within this paper have focused on relating immediate risks and long term risks to the IEA's emissions and temperature scenarios, which are largely reliant on trends in global energy supply and consumption of carbon-based fuel sources. Due to the fact that all businesses, countries, and individuals also rely on these carbon-based fuel sources, whether in goods and/or services, in order to change behaviour, policies must be created that incentivize and encourage a movement away from this level of reliance on carbon-based energy sources and toward a low-carbon world. By examining the self-interested behaviour of businesses and industries, who are at the heart of non-renewable energy production and consumption, policies can be created to play to the motivation of profit-maximizing firms.

Furthermore, by initiating the implementation of value-based ERM frameworks at microeconomic and macroeconomic levels, while simultaneously motivating these businesses through incentivizing subsidies and carbon-pricing mechanisms, the execution of climate policies from the bottom-up will be possible. Although value-based ERM methods have yet to be applied to these wider areas in macroeconomies, increasingly definitive processes are being solidified at firm levels. Therefore, risk management experts are bound to eventually find an integrative way to link climate policy treaties, such as those formed by the UNFCCC, and countries.

Nevertheless, countries must possess the desire and ambition to want to participate in these climate measures. Many governments in developed countries, such as the US's Obama administration, have been made aware of the multitude of scientific data that supports the rapid, human-induced increases of the earth's average global temperatures. National implementations and targets have been set by the Obama administration to limit the country's carbon emission production. However, the US remains firm in their stance of engaging in UNFCCC treaty ratification only if all countries, particularly China, are held to the same standard. In some sense, this is a valid point of view, but becomes a problem when both countries remain at a standstill.

Imagine playing a game of chess and each player is facing a choice to either sacrifice a bishop to get their pawn to the other end of the board, or make another move that avoids losing a chess piece. Now imagine a small fire has been ignited in the corner of the room, but is quickly growing. If both players refuse to sacrifice a small part of their chess team to try to win the game, the game will continue on until the fire engulfs the whole room, requiring the players to abandon the game altogether.

Generally speaking, the US is a first-mover; globally, many countries follow in the steps of the US, whether in fashion trends, music, or business. The world, in many ways, idolizes the "American dream" lifestyle of North America. If the US is truly concerned about emissions reductions in creating a liveable environment for future generations to come, the US must act as a role model for other countries and promote involvement in international climate discussions. If the US displays such a level of support, other countries are sure to follow.

The bottom line behind these research findings is this; if the scientifically-proven transient and long term risks to human civilization, caused by human activities, are not convincing enough to persuade countries to want to take committed, integrative, and determined action today, our governments will have truly failed us all.

Play the game for more than you can afford to lose…only then will you learn the game.
- Winston Churchill

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