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Emerging from Crisis: The Paris Climate Agreement and the New Development Paradigm

by

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"When written in Chinese, the word 'crisis' is composed of two characters. One represents danger and the other represents opportunity."

– John F. Kennedy

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Introduction

Over the last four decades, climate change has garnered global recognition as an existential threat, gradually expanding its reckoning beyond environmental impact to threaten livelihoods, health, economic prosperity and future capacities for growth. Its arrival serves as a symptom of humanity's tendency for excess – we've overexploited hydrocarbon energy sources that have offered us continual, phenomenal economic progress since the mid-1700s. We now face the consequences of this overexploitation in climate change, humankind's third historical energy crisis, and have pushed the planet to its limits with our lethargy to act.

As we confront the possibility of an ill-fated future, a bearer of potential solutions has been born through a chronicled history of climate policy, the Paris Climate Agreement. The landmark agreement has created the case for abandoning the conventional paradigm of fossil fuel-based development and expanding to new horizons of growth through low-carbon energy technologies. Its combination of expansive, global reach and holistic support provision has produced an unprecedented impetus for combatting crisis. Market trends already signal future partiality to renewable energy, so the Paris Agreement expects to compound the rate of trajectory. By analyzing the profiles of three nations - Morocco, Chile and Bangladesh – who exist at differing points along the development pathway and carry varied policy approaches, we can build a platform for extrapolating where developing nations lean in the tug-of-war between renewables and fossil fuels. With national commitments unanimously in favor of long-term renewable energy proliferation, all three countries and their respective relationships with the Paris Agreement are indicative of a larger paradigm shift that disavows fossil fuels in favor of energy sources that can decouple greenhouse gas emissions from economic growth.

This thesis begins with the historical context for humanity's two previous energy crises, detailing their causes, solutions and relevancies to the current crisis. Following this introduction, the thesis is divided into two halves, 1) the historical identification of our current crisis and 2) the forward-looking solution to the crisis. The first section describes the chronology of a protracted political and scientific build up to the Paris Agreement. The critical historical elements of multilateral negotiation, scientific improvement and global protocol formation are detailed and designated for their contribution to current climate change diplomacy. This narrative coalesces with the Paris Agreement, the crown jewel of climate change policy, whose assertion of crisis and endorsement of action have induced unprecedented urgency.

The latter half of the thesis focuses on the transition from crisis identification to multidimensional resolution building through the Paris Agreement. The proposed resolution is a universal evolution away from fossil fuel dependence towards an energy system based on renewable resources. The exploration of this resolution is through case study analysis, completed for three developing countries with differing circumstances and policy schemes. The analyses cover the countries' commitments to the new development paradigm, backed by renewable energy, and examine the Paris Agreement's impact on their respective trajectories.

As the world continues to emit greenhouse gases at a rate beyond natural remission and scientific clarity continues to accelerate, urgency is forecasted for expansion. Historical scientific and political refinement has culminated with the Paris Climate Agreement, whose propagation of a long-term vision for energy evolution has near unanimity in its acceptance. This thesis' synthesized trajectory for the three countries studied speaks to the broadening acceptance of the new development paradigm through which emissions are decoupled from economic growth and endorses the Paris Agreement as the foremost catalyst to date for solving, and emerging, from the energy crisis.

The Relationship between Energy and Crisis

Human history on earth can be divided into four distinct energy epochs, each with their own fundamental energy sources that facilitated development and population growth. In each epoch, reliance on a particular energy system led to the eventual overstressing of its supply and resulted in deep economic, ecological and social crisis. With each threatening crisis, humans adapted by evolving their energy supply systems, shifting away from conventional sources to favor newfound, productive energies that preserved human progress and spurred development. With each necessary, foundational shift in energy, new norms were adopted and human civilization evolved its economic structures, social systems and ecological relationships. In absence of newfound energy sources, human civilization's vitality and survival were in question.

In the epoch of hunter-gatherer societies, rooted in independent, nomadic groups, humans relied on passive solar energy. Passive solar's manifestation was in the form of organic material: all of the natural, harvested nutrients were in one way or another fed by the sun, and nearly all game that was hunted was within two or three trophic levels of autotrophic vegetation. During this epoch, the supply of resources followed natural cycles dictated by passive solar energy. Because of this, resources were slim and didn't support human expansion, yielding the nomadic structure of human civilization at the time (Holger, Wolfgang, & Jürgen-Friedrich, 2012). With the improvement of technology and gradual growth in human population, overhunting and overharvesting became prevalent. Resource constraints grew to hinder population growth, and comprehensive crisis ensued. Without the interjection of a alternative energy system, human development would falter and risk catastrophe. Enter agriculture.

At the tipping point of human cataclysm, some 10,000 years ago, energy demand was nourished by the Neolithic Revolution. This agrarian epoch was built around mechanical energy from domesticated animals, metabolic energy from agricultural cropland and caloric energy from the use of timber (Holger et al., 2012). With the discovery of new sources, energy was much more plentiful; per capita consumption of energy became 60-80 GJ, far and away outdoing the 10-20 GJ that hunter-gatherer societies had at their disposal (Holger et al., 2012). This evolution proved catalytic to human development. Societies were formed, became more sedentary and, with the expansion of controlled agriculture, created the possibility of "free time," which furthered social, political and economic development far beyond what hunter-gatherer society mustered. By confronting the resource shortage crisis, the Neolithic Revolution updated humans' quality of life and formed a foundation for further growth. At the heart of the revolution was the discovery of new forms of energy, originally foreign, that formed the economic engine that redefined the shape of human development.

Eventually, as one could expect in this story, the human operations within this epoch outstripped their energy endowment and crisis ensued. The use of timber became a central component to many societies' infrastructure and fuel, and the management of its regrowth was lackluster. The use of arable land was critical for expanding food production, but human hunger gradually overtaxed its fertility. The consumption rate of resources that has been so vital to human progress overtook the regenerative capacity of their ecological systems and this created social, economic and ecological crisis (Holger et al., 2012). Only an evolution in the energy system could propel human civilization forward.

The answer to the agrarian crisis was an explosion in the use of fossil fuels, particularly coal, initiated by the Industrial Revolution. Coal produced a high-energy surplus with the ability to accelerate economic and social development at a seemingly exponential rate. Its potential was rapidly seized on, particularly in the Western world. Fossil fuel use corrected the fallout in the agrarian energy system, "postponed the time of last judgment (Bunting, 1693)," and expanded the horizons of growth. Once again, per capita energy use skyrocketed, jumping from the agrarian 60-80 GJ to 220-350 GJ. If per capita energy consumption is an accurate gauge of quality of life, the disparity between epochs is telling. The arrival of coal brought on innovations like the internal combustion engine and industrial manufacturing that allowed for an explosion in wealth and living standards. Coal also shifted social and political structures, expanding free-market capitalism, urbanization and inequality. The changes in civilization were dramatic, particularly in the West, and at the heart of it was a seemingly endless source of energy – fossil fuels (Holger et al., 2012). As coal and oil became the backbone for development, the stress on various agrarian energy sources diminished, as the automobile replaced the utility of horses and timber became more dispensable as a source for heating. Of course, as to repeat history, the insatiable human desire for growth has resulted in the overuse of fossil fuels and, over time, crisis has arisen.

In the modern era, the crisis we now face is climate change caused by fossil fuel use and the subsequent emission of greenhouse gases. Once again, we have abused the energy source that once offered us an escape strategy and yielded great progress. As a result, our ecological, economic and social systems are at stake, facing irreversible damage that threatens our development and existence.

The story of this modern crisis has been long-winded. Its drawn-out discovery has been a product of limited scientific capabilities, diplomatic inertia and partisan encouragement of the status quo. It has taken hundreds of nations, thousands of scientists and millions of voices to find action, but after a continuous bout between science and stagnation, action is finally underway to begin the next energy evolution and redefine the current paradigm of development.

The Identification of Modern Crisis

In February of 1979, the First World Climate Conference (FWCC) came to fruition in Geneva, Switzerland. The conference was the first of its kind and scale with the sole purpose of addressing climate issues, established under the joint responsibility of multiple organizing bodies and largely within the frame of the UN. Theories of climate change had been proposed over history, but these theories were considered fringe issues within the larger environmental policy realm. The convening of climate scientists in Geneva from around the globe brought hopes of collaborative publications of climate change projections and was sponsored by one of the foremost bodies on climate science at that time, the World Meteorological Organization (WMO) (Lewin, 2017). Together, the International Council of Scientific Unions (ICSU), the United Nations Environmental Program (UNEP), and the WMO had helped build the first conference dedicated to knowledge around climate change. Each of these organizations had furthered climate science in their own rights.

The ICSU was a research council dating back to 1931 that had long addressed scientific issues. In 1962, the ICSU was elected by the UN General Assembly to tackle climate science, a field that had recently gained traction through preliminary climate science reports. The ICSU played a pivotal role in early climate science, operating through a meteorological focus and capitalizing on newfound satellite technology to better understand global circulation patterns in the atmosphere and oceans (Bolin, 2007).

The World Meteorological Organization (WMO), founded later in 1950, also became a focal organizer of conferences and a lead on climate issues, complementary to ICSU in its approach to climate science through a meteorological lens.

The United Nations Environment Program (UNEP) was a founded as a result of the United Nations conference on Human Environment in Stockholm in June of 1972, intending to provide a platform for all environmental issues to be publicized and discussed. The Stockholm conference was significant in its progress towards the FWCC, bringing together scientists from 14 different countries to collaborate around climate science. The conference's goal was to expand science efforts beyond the individual scientist, and this was succeeded. However, being in the midst of recent volcanic eruptions that produced global cooling effects, the conference concluded that the world "needed more research" before determining that the forcing's of climate change were anything past indeterminate. With the introductory effort of Stockholm, and scientific collaboration encouraged, the stage had been set for the FWCC.

Under primary guidance from WMO and UNEP and oversight from the UN, the FWCC came together successfully in 1979. 450 experts from 60 countries arrived in Geneva with ambitions of advancing climate change science, in what was the greatest gathering of climate change scientists to date. Following vigorous deliberation, the conference concluded with a number of unprecedented declarations. The conference stressed that the impact of carbon dioxide accumulation "deserved most urgent attention of the world community of nations," and it called for accelerated resources "on various aspects of the CO_2 problem (*WMO Conference*, 1979)," given that the "CO_2 problem" was not well understood. For the first time in any council's existence, the FWCC encouraged immediate policy action "To foresee and prevent potential man-made changes in climate that might be adverse to the well-being of humanity (*WMO Conference*, 1979)," and the conference established the World Climate Programme (WCP), later called the World Climate Research Programme (WCRP), whose primary objectives were to determine the predictability of climate and the effect of human activities on climate (WCRP, 2018). Although promising, the conference was still encased in a cloud of uncertainty, as its most resounding calls to actions were simply initiatives for more science. The crisis of climate change has not been solidified, but was now officially on to the radar for environmental issues.

In the wake of this, two years later, in October of 1980, the Energy and Security Act was passed in the United States, requiring a more comprehensive climate change assessment following the FWCC uproar (Lewin, 2017). The report was completed under the leadership of the Director of Scripps Institution of Oceanography, William Neirenberg, and the resulting, largely empirical study released in1983 was dubbed the Neirenberg Report. The report pointed out the unambiguous gaps in current climate science and recommended against immediate policy action – the scientific case for action had not yet been developed fully enough. The report stated CO_2 was a cause for concern but not panic, and action would be both costly and ineffective (Carbon Dioxide Assessment Committee, 1983). Of course, this wasn't a significant surprise; climate science and its subsequent policy were not agreed upon yet, and mitigation action was seen as very disruptive to economic and social systems, even by the Environmental Protection Agency (Lewin, 2017). Even with this, the Nierenberg Report still encouraged further monitoring and analysis and called for well designed programs to be created around climate change science (Carbon Dioxide Assessment Committee, 1983). For the United States, a leader in voice for the UN, climate change deemed no reason to act – the status quo was to continue.

Villach

The Villach Conference of 1985 was met with great positivity throughout the international climate arena and produced the report, "The Assessment and the Role of Carbon Dioxide and of Other Greenhouse Gases in Climate Variations and Associated Impacts." Sponsored in large by the WMO, ICSU and WCRP, the conference gathered 76 representatives from 29 developed and developing counties, producing the primary conclusion that "Support for analysis of policy and economic options should be increased by governments and funding agencies (WMO, 1986)." The subdued call to action for governments was a milestone for climate change science, and was an initial point of transition for climate change from being principally a scientific issue (as demonstrated by Neirenberg) to an international political issue (Cass, 2006). Science and Policy operated in very different sphered for climate change, and there science merely “recommended” policy initiative at this point. Using past climatic changes and future climate modeling methods, the conference came to the scientific conclusion that a doubling of atmospheric CO_2 concentration could have a profound effect on global ecosystems, agriculture, water resources and sea ice (WMO, 1986). In spite of this, the “Impact of Climate Change” working group at Villach argued that the consensus on science was still insufficient to warrant immediate action (Bolin, 2007; Lewin, 2017). Again, the conference referenced the recent cooling phase, which had occurred through coincidental natural forces and had made climate science modeling convoluted (Lewin, 2017). The cooling phase had once again softened the urgency to act. In response, the conference initiated the creation of a new group to perform detailed periodic assessments and recommendations on climate action, combining the forces of UNEP, WMO and ICSU (Bolin, 2007), called the Advisory Group on Greenhouse Gases (AGGG).

The AGGG consisted of top scientists from the subsidiary organizations that created it, aimed to tackle the persistent gaps in climate science. However, the AGGG failed at establishing a connection between these scientists and politicians and partially hindered climate from taking center stage with governments as a socio-political issue (Bolin, 2007). Tackling crisis would require not just recognition of the crisis, but also proactivity to create solutions. Recognizing its weaknesses, the AGGG incited the need for a group with more bandwidth for completing periodic climate assessments that also went beyond AGGG’s scope to initiate global conventions (Zillman, 2009). The wheels for something larger had been set in motion.

In 1987, two years after Villach, The UN General Assembly was held and produced a keynote address dubbed *Our Common Future*. Remarkably, the multidimensional, sweeping statement touched on the topic of climate science. "The burning of fossil fuels puts into the atmosphere carbon dioxide, which is causing gradual global warming. This 'greenhouse effect' may by early next century have increased average global temperature enough to shift agricultural production areas, raise the sea level and flood coastal cities, and disrupt national economies (WCED, 1987)." *Our Common Future* conveyed alarmism, helping solidify the urgency required of both climate change science and policy. However, what may have even been more profound for its time was the report's statement on development. *Our Common Future* included the call for economic growth that "sustains and expands the environmental resource base" while relieving poverty (WCED, 1987). The idea of "sustainability" was foreign language to the diplomatic realm, and representing the beginnings of something large.

Up until the 20th century, for centuries the discussion around the term "sustainability" was restricted to forestry practices (Holger et al., 2012). This originated as far back as the 10th century, evolving into what was known as the *Allmende* system in the countryside of Europe in the 17th century. The system managed forest resources through protection and local regulation, allowing long-term viability from resources that would otherwise be exploited and exhausted (Holger et al., 2012). By managing resources properly, communities' development had longevity and diminished impact. It wasn't until the 1960s the principles of "sustainable development" made a quiet re-entrance through the US Congressional National Environmental Policy Act of 1969, which incited a harmony between man and nature (Holger et al., 2012). Regardless, the paradigm of the times was the environmental protection would slow economic growth, and this held fast (Egelston, 2013).

Our Common Future was a breakthrough for the idea of sustainable development. It argued that sustainable development did not directly imply limiting growth, but rather that improvements of our technologies and policies can allow us to discover a new form of economic growth in tandem with environmental interests (WCED, 1987). This was unprecedented for its time, given that since the Industrial Revolution, economic growth had been innately tied to the exploitation of the environment and use of harmful hydrocarbons. *Our Common Future* subscribed to an ideal where "the needs and aspirations of the present without compromising the ability to meet those of the future (WCED, 1987)," arguing for a strong recognition of the future in our current development policy design – a policy design that needed to be interdisciplinary (Dunn, 2010). Although there was little tangible research on sustainable development, the report helped popularize the idea and sparked a new phase in the environmental agenda moving forward (Dunn, 2010).

The Montreal Protocol

Following the momentum of the UN General Assembly, two years later in 1987 the world witnessed an unprecedented global environmental agreement, the Montreal Protocol. Just a year earlier, in 1986, through a collaboration among scientists, the British Antarctic Survey had announced the discovery of a hole in the protective ozone later of the atmosphere. The causes were Chlorofluorocarbons (CFCs), chemicals produced for consumer products around the globe. Impressively, within only one year, countries expedited an international agreement committing to reduce their emissions of CFC's by 50% in the near term and even more thereafter. Only 18 months after the discovery of the issue the problem had been solved, serving as a global realization that the international community could in fact effectively produce multilateral environmental action and in a timely matter. This result was unexpected and generated optimism around the potential for multilateral negotiation to solve large scale issues. Witnessing this success, the WMO and UNEP expressed the need for a collaborative, international solution for clarifying the science of climate change. The WMO claimed that it was not able to meet the requirements mandated such a massive issue, the AGGG did not have the bandwidth for comprehensive global assessments. Through the example of the Montreal Protocol, it became clear that an *intergovernmental* organization could offer resource expansion to solidify the science, bring science closer to policymakers, and place a more demanding policy burden back on governments (Lewin, 2017). This set in motion the foundations of the Intergovernmental Panel on Climate Change (IPCC).

On June 23, 1988, climate researcher James Hansen produced a testimony for the United States Congress on the hottest day of the year, titled *The Greenhouse Effect; Impacts on Current Global Temperature and Regional Heat Waves*. Covered in sweat in a boiling congressional hall, Hansen delivered what may climate activists had hoped for, declaring that the climate was changing in accordance with greenhouse gas production and “there was only a 1% chance of accidental warming of this magnitude (*Greenhouse Effect and Global Climate Change*, 1988).” The testimony received front page cover stories that circulated worldwide, and helped spark the urgency around global warming, which was quickly becoming a crisis (Lewin, 2017).

IPCC

Riding the wave of urgency into the UN General Assembly in 1988, a monumental deal was struck and the Intergovernmental Panel on Climate Change was established. The IPCC’s overall goal was the prepare assessments on all aspects of climate change and its impacts, with the objective of formulating realistic response strategies (IPCC). It would do this through structured procedures and with the assistance of groups like the WMO, UNEP, ISCU and WCRP. Working groups were devised numbered roman numeral I through III, meant to divide and conquer, with each respectively covering (I) the scientific information available, (II) the environmental and socio-economic impacts created, and (III) the response strategies to those impacts (IPCC, 2010). The following principles of the IPCC were critical to the credibility and success of the organization:

- Policy relevant but not prescriptive (IPCC, 2010): Policy choices of governments were contingent on national positions, multilateral discussions, and interpretations of science – the IPCC was to be merely informative and assist these discussions

- Objectivity (IPCC, 2010): in order to abstain from possible bias, no member of the IPCC was to be paid
- Openness (IPCC, 2010): global credibility demands global representation. Widespread participation, particularly from developing countries, was encouraged (Agrawala, 1998)
- Transparency (IPCC, 2010): Increased transparency minimized skepticism
- Scientific Integrity (IPCC, 2010): The IPCC peer review process develop into a system many times more rigorous than the average scientific journal (Agrawala, 1998)

It was intended that the IPCC first major assessment report be finished by the Second World Climate Conference (SWCC) in 1990. Because of climate change science's historical focus on the identification of the impending crisis, there was initially a dearth of socio-economic experts represented in the IPCC (Bolin, 2007). One argument for a larger socio-economic presence was the need to be able to reach the public, stake-holders, decision-makes and politicians in a palatable fashion. On the other hand, a hard distinction between science and politics was outlined in the IPCC's principles needed maintaining (Bolin, 2007), making the organization's objectives cloudy. These discussions of intentions would come to continue for as long as the IPCC would exist.

The Hague Declaration

With strong wind behind the sails of climate activists, a comprehensive global climate science report being completed, and the connection fusing between climate science and policy, The Hague Conference of 1989 put climate change into focus for governments. It's keystone product, *The Hague Declaration*, asserted that climate change was an imminent threat to ecological systems that were most vital to the interests of developed countries (*Hague Declaration on The Environment*, 1989). It called attention to development, arguing for sustainable development coordinated across international lines even though the concept has still foreign to governing bodies and had no guiding structure. *The Declaration* also said that a new global approach to development needed more effective decision-making and enforcement, and this decision-making would come from a "new institutional authority (*Hague Declaration on The Environment*, 1989)." Thus far, the only primary institutional authority for international negotiation was the IPCC, and with *The Hague Declaration*'s mandate for economic development guidance as well, it was suddenly given larger shoes to fill in the short-term. In the long-term, it was clear that another organization needed founding to tackle the "decision-making" side of the IPCC's science – this would eventually become the United Nations Framework Convention on Climate Change (UNFCCC).

First Assessment Report

The First Assessment Report (FAR) of the IPCC was released in August of 1990. The comprehensive report received much fanfare for the achievement of consolidating a multitude of varied contributors to climate change science. Working Group I (WGI), whose concern was to build science, declared only two things with certainty: The natural greenhouse effect keeps the Earth warmer than it would otherwise be (IPCC, 1990c), and that emissions from human activities (included but not limited to CO_2, methane, NOx) increase the greenhouse effect and global warming (IPCC, 1990c). The group covered the effects of other emissions, from aerosol cooling to CFC ozone depletion and so on, and outlined both the improvement and weaknesses in modeling for all emission types. Summarizing all of this, the group claimed that the next century would see a temperature increase of about 0.3 degrees centigrade per decade (with uncertainty, a range of 0.2-0.5), alarmist prediction.

Based on WGI's prediction, WGII noted the possible impacts of such a temperature raise. Changing natural terrestrial ecosystems would alter migration patterns and negatively affect biodiversity; precipitation patterns would shift and place stress on water resources and agriculture; snow cover loss and receding glaciers would affect water availability; ocean warming would result in altered ocean circulation and sea level rise, impacting coastal areas with flooding and population displacement (IPCC, 1990a). The list of stresses was exacerbated by the WG's discussion of the dynamic globe itself, harping on the fact that populations will change over time and increase their demand for goods that increases stress on lands, oceans and the energy supply; climate change will accentuate these issues. This will be particularly noticed in developing countries where populations are low income, and in coastal lowlands or islands near natural hazards (IPCC, 1990a).

Even with such menacing expectations for global population issues and natural disruption, the IPCC references the large amounts of uncertainty that still needed to be resolved. Agriculture was one cloudy area: regional impacts on topics like precipitation and soil moisture had very low confidence, the interaction of warming and agricultural productivity was not well understood. Solidifying WGI's estimations was critical. Having a good understanding of the effects of emissions on the climate, which was not the case, was fundamental to identifying the resultant biological, ecological, physical, and socio-economic consequences (IPCC, 1990a).

Working Group III addressed what responses were appropriate to counteract and withstand climate change, following WGI and WGII's information. In order to identify what responses were appropriate, WGIII considered three large foci. The first was to delineate between countries and their responsibilities for climate change. Through the WIII's discussion of historical contributions to climate change, the IPCC discerned between developed/industrialized countries and developing/unindustrialized countries. The IPCC argued that developed countries had contributed considerably more emissions throughout history, garnering more benefits from earlier fossil fuel adoption, and were therefore larger culprits of climate change and had larger obligations to take domestic action (IPCC, 1990b). Additionally, developed countries needed to provide funding for technology transfer in developing countries for the sake managing climate change (IPCC, 1990b). The IPCC argued that developing countries had the right to continue increasing their emissions, out of fairness to the history of aggregate emissions. The second focal point of WGIII was the stress placed on sustainable development. Continuing the theme of support for developing countries through financing and technology (Agrawala, 1998), the IPCC argued that economic development will increasingly take into account the issue of climate change over time (IPCC, 1990b). Ideally, the world could foster environmental adaptation/mitigation while developing economic systems (IPCC, 1990b), generating co-benefits that made a better world. At that time of WGIII, there were very few tangible solutions by which to do so and most ideas were purely theoretical, but nonetheless, a new paradigm was encouraged where economic growth no longer compromised our planet's stability and vitality. The third significant argument made by WGIII was that adaptation should be targeted sooner rather than later (IPCC, 1990b). The sooner you adapt, the more you minimize the costs of adaptation; the longer you wait, the closer vulnerable countries could be pushed to the brink. The IPCC's call for adaptation paralleled its allowance of unrestricted economic growth in developing countries, given that lack of economic prosperity was a key determinate of vulnerability (IPCC, 1990b).

FAR warned about alarming projections of rapid warming and sever global threats, but these fears were mostly future-looking because of the demonstrated uncertainties. Specific causes of uncertainties included the study of carbon-removing sinks, how clouds influence the magnitude of warming, how oceans influence patterns of climate change, and how substantial ice melt would raise seas levels.

Generally, uncertainties revolved around broader, regional patterns of climate change, and asserted the need for more regionally focused climate research (IPCC, 1990c). The IPCC was very forward with their uncertainties, and welcomed critical examinations of their conclusions by anyone who disagreed (IPCC, 1992), maintaining their principle of objectivity. Of all the uncertainties ahead of the IPCC, completing the connection between emissions and warming, and exacting the relationship between the two, would be critical to pushing climate science further into the policy realm by enabling tangible targets to be set. Concerning policy, the IPCC stressed that action should start upon FAR's completion, hopeful that the report would provide a basis for effective cooperation on climate change action (IPCC, 1990b). The IPCC hoped this cooperation would come in the form of a convention, which could outline the procedure for furthering research, monitoring, and making progress on technology/financial transfer from country to country (IPCC, 1990b). This fell directly in line with *The Hague Declaration*'s call for a body to be a "new institutional authority." A convention that captured so many responsibilities did not exist at this point, and there was a gap that needed to be filled.

Overall, FAR didn't offer a 'silver bullet' for fixing climate and didn't even pin down exactitude around climate change and its effects, but there was much to be celebrated. The format for building a comprehensive understanding for climate change, its effects, and the world's response had been successfully created. More so, there was incredible foreshadowing of long-term issues in international policy as the IPCC mentioned the tug-of-war between development and emissions control, the "fairness" of who's responsible for climate change, the urgency of adaptation, and the proposition of sustainable development. Above all, FAR helped define the impending dangers of climate change and foreshadowed what the economic, social, and ecological crisis could look like.

The Second World Climate Conference

The Second World Climate Conference (SWCC) arrived in October of 1990 in Geneva, just two months after FAR had been released. It's objectives were twofold – analyze the progress of World Climate Programme (WCRP) and undertake an international review of FAR (Zillman, 2009). The SWCC published recommendations for action in food, water, energy and land use. To help tackle global climate science uncertainty, SWCC formed the Global Climate Observing System (GCOS), which was meant to be a collaboration among the world's top scientists from constituencies like the WMO, UNEP and ICSU to create an advanced, all encompassing climate modeling system across time and borders (Zillman, 2009). In its published review of FAR, the SWCC also set the parameters for the creation of an organization (the UNFCCC) for cooperative international action that filled various necessary gaps like policy recommendations, conference building, and collaborative deal making.

Almost concurrently timed with SWCC, the International Geosphere-Biosphere Programme (IGBP) conference in Bellagio, Italy in December of 1990 led to the formation of another critical research body, the System for Analysis, Research and Training (START) ("IGBP Releases Plan for Global Change System for Analysis, Research, and Training," 1991). The founding body, the IGBP, was launched under sponsorship of the ICSU in 1986, with the mission statement to "understand the interactive physical, chemical and biological processes that regulate the total Earth system, the unique environment it provides for life, the changes that are occurring in this system, and the manger in which they are influenced by human action (IGBP, 1991)." With the help of the WCRP, IGBP's START was formed with the objective to inform national, regional and international policy formulation for collaborative action. To achieve this, the actual undertaking of START was scientific, motivated by the need for accuracies in global climate science to increase. The task was huge, but the motivation was large. In the build up to START, the IPCC's FAR had stressed the need for cooperative science. Compounding this, the SWCC encouraged an increase in regional, interdisciplinary research centers. Looking even father back, it had been collectively agreed, since the time of the WCED and *Our Common Future*, that climate change was outstripping the ability of scientific disciplines (WCED, 1987). START intended to address all of these calls to action.

Outlined in the Bellagio Report, START would have regional research networks, rooted at a regional research center that captured reported research within their respective jurisdiction. ("IGBP Releases Plan for Global Change System for Analysis, Research, and Training," 1991). When aggregated, these regional recordings would provide a comprehensive global average for changes and patterns. As outlined by FAR and echoed by SWCC, regional misunderstanding within climate change science was a bane to accurate climate science, as different regions are to be impacted in very different ways based on their particular characteristics. START hoped to tackle regional differences and solve a fundamental is in climate science.

The research centers within regions would be located primarily in developing countries, due to the fact that those countries had a more urgent need to understand the potential impacts of climate change. At the time, there was a dearth of research within tropical regions (which are largely comprised of developing countries) and their specific issues of monsoons, El Nino, and hurricanes. Current research also took very little focus on traditional crops of developing countries such as pulses, roots, and oilseeds ("IGBP Releases Plan for Global Change System for Analysis, Research, and Training," 1991). Not only was START keen on addressing regional and developing country research, but the research was intended to be completely interdisciplinary, providing fully integrated studies of global change across the disciplines of natural science, social science and engineering (IGBP, 1991) and allowing research to be tailored towards not only understanding, but addressing impacts. Although START believed this interdisciplinary approach was most effective, it was first and foremost concerned with reducing scientific uncertainty about global climate systems before building out impacts and responses (IGBP, 1991). START rationale for this was largely intuitive. In order to create agricultural policy somewhere, you must understand the specific area's parameters of future water availability, soil aridity, precipitation, and so on before you choose a policy solution. Having regional analysis allowed said policy to be tailored to a specific location. With START's wide ranging focus and global coverage, the interaction between science and technology within the context of societal development had never been stressed more. The duo of the Bellagio conference and SWCC demonstrated that an unprecedented collaborative effort needed to be made.

At the UN General Assembly of 1991, the International Negotiation Committee (INC) was created, with the general purpose of managing the negotiation and policy side of climate action that the IPCC intended not to partake in (Agrawala, 1998), while also participating in policy research in collaboration with other global programs like START. The IPCC believed that climate change was closely linked to development and therefore was not a strictly natural-science issue, pressuring the UN General Assembly to offer a political outlet for their work (Agrawala, 1998). The creation of the INC meant that the IPCC was no longer a designated forum to debate policy, and climate science and policy were formally split into two separate intergovernmental mechanisms. The dual creation of the INC and START marked a monumental change from simply problem definition to international policy response (Cass, 2006), and served as a symbol of recognition that action was becoming more vital. Altogether, the split in climate change science and policy demonstrated that action was expanding – both disciplines now had their own independent, international bodies for separately focusing and mutually guiding one another.

The Rio Earth Summit

The Rio Earth Summit was held in 1992. It was expected that the conference, officially called the United Nations Conference on Environment and Development (UNCED) would produce the new governing body of climate negotiations that could catalyze global action. For the sake of improved negotiations, the IPCC provided an updated overview of FAR for Rio (IPCC, 1992). Unfortunately, the overview still maintained ambivalence around warming. The community had hoped for a strong case for climate action, but without decisiveness, Rio's call to action was instead built around the "precautionary principle." This principle argued that in areas lacking scientific certainty, if the corresponding threats provoked irreversible damage, uncertainty was not a strong enough reason for postponing cost-effective measures to prevent environmental/socio-economic damage (Liverman, 2009). As expected, the precautionary principles wasn't nearly enough to convince politicians to act and put forth public funding.

Although science didn't find the foothold it hoped for at Rio, the resulting international treaty agreed on the monumental formation of the United Nation Framework Convention of Climate Change (UNFCCC), an organization that answered the calls of policy makers and scientists alike. The UNFCCC was the organization that *The Hague Declaration* beckoned for, that the FAR had stressed the need for, and that the SWCC had laid he groundwork for. The UNFCCC was built around a number of core principles underpinning future climate science development and policy action:

- Protect the climate system for future generations, on the basis of equity and in accordance with respective capabilities and responsibilities (UNFCCC, 1992).
- Developing countries, who have more vulnerability and would have to bear disproportionate burden, need to be given full consideration.
- All parties "should promote sustainable development. Policies that protect against climate change should be integrated with national development programs," because "economic development is essential for adopting measures to address climate change(UNFCCC, 1992)."
- The Parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change.

The UNFCCC's pillars echoed much of the IPCC's FAR, pushing forward a number of principles that at the time, and into the future, were controversial between nations.

Article 7 of the UNFCCC's treaty outlined another item that had been discussed and encouraged regularly through the UN General Assembly meetings, the IPCC, START, and others – the formation of a regular intergovernmental conference on climate. These annual conferences, dubbed "Conference of the Parties" (COP), would be attended by constituents of all participating nations, and would function as the medium through which the UNFCCC would operate. In theory, all nations would become a part of the UNFCCC, and would therefore participate in the COP's, creating a global structure for deliberation. The COP would facilitate the exchange of information on measures adopted by the "parties" to address climate change and its effects, taking into account differing circumstances, responsibility and capabilities (UNFCCC, 1992). The COP was intended to be an annual review of progress on climate change, assessing the implementation of measures and their effects on parties' environmental, social and economic wellbeing. It would guide the process of limiting emissions, and make recommendations on necessary matters of implementation. It would cooperate not only with intergovernmental constituents, but also with non-governmental bodies and competent international organizations (UNFCCC, 1992). The COPs were an unprecedented act on holistic cooperation, and their conception formed a global, intergovernmental platform for discussion, negotiation, agreement, and the furthering of science and action around climate change.

The formation of the COPs also meant that global "protocols" could be adopted (UNFCCC, 1992). Article 4 of the UNFCCC's formative agreement stated that all parties, within their capacities and responsibilities, were to take measures to limit their emissions in the long-term. To meet these commitments, protocols were to be utilized. These tools intended to function much like the Montreal Protocol did in 1987, creating binding agreements between parties on emission reduction commitments. These protocols were designed to achieve emissions reduction through collaborative effort. In order to partake in the protocols, you needed to be a member of the COP annual conferences. To facilitate cooperation with protocols, "financial mechanisms" were also approved under the treaty. These mechanisms encouraged the provision of financial resources on a grant or concessional basis, including the transfer of technology, and were intended to have an equitable and balanced representation (UNFCCC, 1992). Laying the groundwork for future, international investment vehicles was important, and eventually low-emissions investment became a cornerstone of protocol agreements, offering co-benefits of development and simultaneous emissions reduction. The COPs were monumental in that carbon emissions could now, potentially, be mandates to be lowered through international agreement, opening the door to global action on the climate change issue.

The UNFCCC agreement also distinguished between so-called "Annex I" and "Annex II" countries. Annex II countries were comprised of all participants in the Organization for Economic Co-operation and Development (OECD), all of which were highly developed countries. Annex I was comprised of those OECD countries *plus* countries dubbed "Economies in Transition" (EiT) which were moderately developed countries and, at that time, were primarily eastern European countries (Egenhofer, Kjellén, Convery, & Wråke, 2008). Those not included in either Annex were newly industrialized or developing countries. The grouping method meant that Annex II, being the richest and most developed countries in the world, were required to provide additional financial resources and technology transfer to developing countries parties, who were most vulnerable to the adverse effects of climate change. The success of all parties relied on "adequacy and predictability in the flow of funds and importance of burden sharing among the developed countries parties (UNFCCC, 1992).” Socio-economic experts assured that this support would be by no means perpetual; technological transfer offered countries considerable endogenous growth (UNFCCC, 1992), decreasing external reliance and allowing development to be generated internally. Endogenous growth is a slow process, though, and the UNFCCC urged countries to be patient in the development of economies undergoing a transition, particularly for those that rely heavily of fossil fuel generation for income. At the time, there was little expectancy for fossil fuels dependence to be lowered at the time – the only potential replacement, renewable energy, was expensive in many of its forms and still within initial stages of growth.

Ultimately, the formation of the UNFCCC laid the groundwork for negotiating deals to reduce global emissions and sustainably develop nations, strengthening the fabric that interwove the environmental and economic interests of both developed and developing countries. All parties had commitments to “prepare national inventories of greenhouse gas emissions, implement measures to mitigate climate change, promote and exchange research on climate change, and cooperate around transferring and developing technologies with mitigative/adaptive features (UNFCCC, 1992).” With a laundry list of climate action items to work through, the newly structured COPs set to work.

Alongside its creation of the UNFCCC, a second important output of the UNCED in 1992 was raised espousal of sustainable development. The conference established the framework for standardizing sustainability goals with intentions for the goals to be transferred into actionable policy, as outlined by “Agenda 21.” The Agenda was meant to introduce sustainable development as a commonplace concept and provide an impetus for the globe to act on its principles. For the purpose of defining these principles, the conference also established the Commissions for Sustainable Development (CSD). This group was designated to setting the parameters of sustainable development and building the tools for monitoring progress (Holger et al., 2012). The Commission hoped to further the integration of economic development with environmental conservation at the local, national and global levels (Dunn, 2010).

The definition of sustainable development has been under revision since the time of the UNCED and FWCC before it. Following decades of international negotiations and guidance from organizations like the CSD, sustainable development's solidifying definition is as a concept that intertwines economic growth, social justice and environmental protection. Sustainable development argues that there exists a compromise between the causes of the rich (environmental protection) and the causes of the poor (economic development) (Holger et al., 2012). Defining the concept is still under way, obstructed by the fact that the term is meant to be all encompassing to tackle issues of equal access to natural resources and technology transfer as well as encouragement of transparent political processes (Egelston, 2013). Additionally, many of its tenets require a shift in global perspective, from protectionist and competitive to collaborative and supportive. This has been a large ask of the sustainable development concept, especially at the time of its entrance with the UNCED in 1992.

In many ways, Agenda 21 was overly ambitious for the time, due to its inability to advise realistic policy. However, by entering onto the international stage in tandem with the UNFCCC at the United Nations Conference on Environment and Development, the Agenda's disruptive rhetoric was not disengaged, and sustainable development began its positive trajectory into prominence (Egelston, 2013).

COP1

COP1 came in Berlin, Germany in 1995, three years after the formation of the UNFCCC. Filled with enthusiasm, the deliberators at the COP were highly successful in charting a path in the build up to what would eventually become the Kyoto Protocol in 1997, by establishing the process for negotiation of strong emissions reduction commitments (UNFCCC, 1995). In anticipation of the protocol, the COP increased the urgency and strength of Article 4 of the UNFCCC, which demanded that countries make commitments to help reduce globes emissions in the long term. This meant parties needed to elaborate on their potential policy options and measures and set quantified limitation and reduction objectives within specified time-frames. Setting concrete emission targets had not been done before with greenhouse gasses, and the proceeding report of the conference, *The Berlin Mandate,* stressed how important the establishment of binding commitments for developed countries would be (UNFCCC, 1995).

A few months following the first COP in 1995, the IPCC released the *Second Assessment Report* (SAR). SAR's goals were largely in line with the UNFCCC's, presenting two forward looking challenges: determining what concentrations of greenhouse gases may constitute “dangerous anthropogenic interference,” and how we can chart a future towards sustainable development (IPCC, 1995). Positively, overall scientific uncertainties had been diminished through the advancements of SAR and underlying bodies of WMO, UNEP and START. However, more uncertainty had been uncovered in other places, like damage measurement. The SAR had developed the idea that damage in some areas, as a result of climate change impacts, was not equal to the damage experienced by the same impact in different areas (IPCC, 1995), simply due to differences in nations’ wealth. This meant that the attribution of “damage” was subjective, depending on the dynamics of vulnerability in people and ecosystems, and this skewed idealized international emissions targets (Liverman, 2009). Working Group III wrestled with the issue, undertaking economic analyses of impacts and mitigation values across regions and nations (IPCC, 1995). This was largely a task of uncovering the social cost of anthropogenic climate change, an issue persists even today when considering “nonmarket” values like the monetary benefit of ecosystem preservation. Evaluation of human impacts were/are just as convoluted, requiring social scientists to estimate the monetary “value of life” which may not be consistent across countries with different national incomes (IPCC, 1995), adding another host of issues concerning equity. Although SAR better clarified surface level climate science, it demonstrated the immense complexities that remained below the surface.

The idea for a global protocol that reduced greenhouse gas emissions had been discussed by climate scientists and governments since the very dawn of the climate change issue. However, the foundation for such a massive agreement was ultimately built from the creation of the UNFCCC in 1992, the Berlin Mandate's call for emissions commitments in 1995, and the impetus of SAR's clarity around the scale of crisis and need for action. A major agreement was now in the works, and nations expected COP3 in Kyoto, Japan to be the location of its formation. In the buildup to Kyoto, the sentiment was promising. In October of 1997, in anticipation of COP3, the president of one of the leading countries in the COP negotiations, the United States, delivered a speech describing a vision for the nation's new economy. US President Clinton proposed his outlook where shifting away from inefficient energies would create new avenues for business and strengthen, not weaken, our economy (President Clinton, 1997). He cited the UNFCCC's financial mechanisms, outlining a potential international emission trading system that could "provide incentives and lift road blocks," and he claimed that a market system for reducing emissions would be the cheapest method of emissions reduction, citing the successful quantity limiting scheme the US had used for sulfur dioxide and acid rain (President Clinton, 1997). Those opposed to Clinton in the US had their say as well, particularly by individuals whose work intersected with the fossil fuel industry and scientists that retained doubt around climate change's reality (Flannery, 1997). With powerful vocal opponents and the complexity of organizing an unprecedented protocol of this scale, a backdrop of skepticism was visible. However, through the progression of COP3 and its ensuing arduous negotiation process, the Kyoto Protocol was eventually formulated and adopted on December 11, 1997, a moment of huge success in an ongoing legacy of international struggle with the climate change issue.

The Kyoto Protocol

The overall goal of the Kyoto Protocol was in accordance with the UNFCCC's mission statement: to limit greenhouse gasses to a concentration in the atmosphere that would prevent dangerous anthropogenic interference with the climate system (UNFCCC, 1997). After receiving input from the UNFCCC, IPCC, and underlying scientific organization, Kyoto's explicit goal was to reduce Annex I (developed countries and EiT) emissions of 6 different greenhouse gasses (CO2, Methane, Nitrous Oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) 5% below 1990 levels by the end of 2012. The 1990 base year, of course, was a reflection of the original IPCC FAR release. The overarching benchmark of Kyoto was to limit the warming to 2° above pre-industrial levels. The choice of using degrees versus parts per millions (ppm) concentration in the atmosphere was a topic of debate, but it had eventually been decided that limits in accordance with the IPCC's SAR were necessary. The benchmark of 2° was important to the climate science community, as the IPCC had correlated this level to disaster - drastic increases in heat waves, floods, droughts, pest outbreaks and general ecosystem disruption (IPCC, 1995; Liverman, 2009). No matter the case of measurement, it was established that binding commitments, i.e. mandatory commitments, would be necessary pieces of Kyoto in order to eventually stabilize emissions. The expectation that developed countries would voluntarily reduce their emissions was very low, and the goals of the protocol were ambitious enough (given the prevailing skepticism and unfamiliarity with climate change) that doing so would have the be a mandatory effort (Grubb, 2004). The line in the sand had been drawn between developed and developing countries, and developed countries had ultimately undertaken the responsibility they deserved.

The Protocol was built around two consecutive commitment periods. The idea behind multiple periods of commitments was the desire to have a dynamic, evolving system that tackled climate change over the century, versus a decade (Grubb, 2004). The first commitment period was set to take place from February of 2008 until December of 2012. All Annex I countries were to reduce greenhouse gas emissions to certain levels during this period and needed to do so through concrete, quantified commitments. The emission target proposals were prepared domestically be each respective country before being put forward, discussed, and finally integrated into the agreement, with the hope of the aggregate reductions equating to a 5% global reduction (UNFCCC, 1997). The national commitments varied based on national growth and development, following both the IPCC and UNFCCC guiding philosophies that contributions should be based on capacity and responsibility. For instance, the EU-15 (Western Europe) had a target of 8% below 1990 emissions, Russia had a target of equal to 1990, and Australia was targeted 8% above 1990 (Dinar, 2013). Based on whatever commitments a country offered, the resulting total emission allocation to that country was quantified with “assigned amount units,” or AAUs. Each AAU represented one ton of CO_2, and the total number of AAUs a country was permitted corresponded to the amount of CO_2 they were able to emit to meet their commitments. For the Annex I countries that actually ratified their commitments, they were grouped into so-called “Annex B” countries, which from a UNFCCC perspective, would hopefully mirror the constituents of Annex I. Annex B countries were allowed to use offsets of carbon sinks in land use, land-use change, and forestry sectors (LULUCF) to meet their goals, which pertained to things like forest management and soil sequestration. Additionally, Annex B countries could use the economic benefits of flexibility mechanisms to meet their targets, as outlined in the founding UNFCCC treaty. These mechanisms crossed all borders, beyond Annex B countries, and meant that those without commitments (mostly low-income developing countries) could indirectly participate in Kyoto. Both the LULUCF and flexibility mechanisms were not initially incorporated in the Kyoto Protocol, but with persistent support from a select number of countries like the US, were eventually included (Dinar, 2013).

The second commitment period was intended to be from January 1, 2013, just following the end of the first commitment period, until December of 2020, when another, new agreement was expected to succeed. The second commitment period was intended to update the list of greenhouse gasses reported by Parties and amend the protocol of any issues. Upon review of the initial agreement, the IPCC recognized that the first period commitments were “modest,” and claimed that there needed to be deeper emissions reduction requirements to meet the intended goals of limiting warming to 2°C above pre-industrial levels (Dinar, 2013). This, however, was not something the COP and UNFCCC felt was destructive to the agreement's success, because the commitments would be dynamic and evolving. Long-term, the hope for emission reduction was 2°, which the IPCC believed meant peak atmospheric CO_2 levels of somewhere around 450 ppm before falling (IPCC, 1995). This was an ambitious goal for a globe that was (and still is) expanding dramatically economically. The initial national targets were first concrete steps in a long process, not definitive solutions. This was reflective of the Montreal Protocol's approach that proved successful, initially cutting CFC's by 50% before iteratively ratcheting up requirements (Grubb, 2004).

For coordinating emissions reductions around the goal of 2° (and therefore 450 ppm), policy makers needed structured models of emissions trajectories and stabilization of those trajectories. Stabilization, in this context, means balancing Earth's natural capacity to remove greenhouse gasses from the atmosphere with the amount of greenhouse gasses emitted(Stern, 2006). There is a direct tradeoff between how serious you limit emissions now and in the future - the longer you delay, the harder (and more expensive) it becomes (Stern, 2006). Therefore, the relative size of Kyoto's agreement was not as important to policy makers as simply completing the agreement and process of reduction. Part of the importance of this proactive stabilization effort is the complexity of modeling Earth's stabilization. For instance, natural carbon absorption could weaken, increasing the need for active reduction efforts, or possible unpredicted human removal of carbon sinks like forests would require compensation elsewhere (Stern, 2006). Because these factors can cause variations within the actual trajectory of global emissions towards 450 ppm, and because the target of 450 is, in itself, subject to change, the Kyoto Protocol was clear sighted on adopting a process focused on iteration that took action earlier.

In COP3 negotiations, it became clear very quickly that there were hot-button issues related to equities and arguments over “fairness.” The principle of “common but differentiated responsibility” was firmly entrenched into both the IPCC the UNFCCC’s operations, arguing that emission controlling must reflect the national difference in wealth, greenhouse gas emissions, and capacity to make reductions (Grubb, 2004). Since the arrival of the Industrial Revolution, developed countries had generated more benefits from fossil fuel use and has contributed considerably more greenhouse gases cumulatively; developing county emissions were still relatively low and expected to grow (UNFCCC, 1995). The Montreal Protocol had subscribed to this principle, limiting their CFC reductions requirements (McGee & Steffek, 2016). In negotiations, the United States felt particularly strong that it would be disadvantaged by a structure that favored developing countries, arguing that the growing “Asian Tiger” countries had comparable emissions levels (Grubb, 2004). Bubbling up tensions, the EU countered that heavily industrialized countires had historically-rooted obligations to provide opportunity for developing country growth, and emissions commitments must be reflective of different starting points, economic structures and resource bases (Grubb, 2004). Beyond emissions obligations, the

UNFCCC recognized that heightened vulnerability and lack of research required an amount of support in developing regions. Less developed countries had the diminished defense against natural disasters, sea level rise and adverse climate impacts, which meant hindering emissions (and therefore development) could be a bane to the population's resilience (Liverman, 2009). This ongoing debate was indicative of the dominant paradigm of the time that development and emissions could in no way be decoupled – there surely weren't strategies to develop *while* mitigating for climate change.

Kyoto Economic Properties

All countries acknowledged that developing countries should be given "positive incentives" to participate in Kyoto, but there was disagreement over what or how large those incentives should be (Egenhofer et al., 2008). In theory, mechanisms for economic growth in non-Annex I countries could bring countries with emerging economies into the developed world, and therefore, into the sphere of emissions reductions, more quickly than through otherwise individual action (Grubb, 2004). After all, the IPCC wagered that developing countries would never be able to reach the same fossil fuel use of now-developed countries during their respective growth periods (Bolin, 2007), due to the ceiling that climate change imposed, so assisting to limit their future emissions would be critical.

When covering the economics of climate change, the Kyoto Protocol encouraged countries to take individual, government-led action to address climate change through energy efficiency, subsidy reform and technology dispersion that would ultimately phase out “market imperfections” related to the climate change (UNFCCC, 1997). However, the parties to the protocol also attested that climate action on a global scale could not practically happen through only individual government capacity. Government transfers would simply not be enough, so mechanisms for cooperation were necessary (Dinar, 2013). The debate around the cooperative mechanisms was largely philosophical, with the EU contingent focused on a “top-down” approach that required countries to make internal changes to reduce emissions a certain level. The US and Japan, primary figures of the opposing contingent, desired a “bottom-up” approach, that allowed countries to take actions externally through investments to “create” emissions reductions in other countries that counted domestically (Dinar, 2013). Some other supplemental financial components had been created by the Protocol, like an adaptation fund that financed adaptation projects in developing countries who were readily threatened by the impact of climate change ("adaptationfund.org,"). However, what became the center of much debate, and was the eventual centerpiece of the Kyoto Protocol’s economic attempt, was the creation of market mechanisms.

The proposed market mechanisms were dubbed “flexibility mechanisms” due to the fact that they were voluntary, had no minimum or maximum desired emissions goals, and worked across borders (Dinar, 2013). These flexible mechanisms would have the desired effect of lower marginal costs for reducing emissions. This marginal emission reduction cost was called an “abatement” cost (Dinar, 2013), and measured the monetary cost reducing emissions by one ton of CO_2. The differences in marginal abatement costs between each country were partially determined by their underlying regional economic and technological characteristics. The largest determinate, however, when finalized, would be the institutional make up of the different mechanisms (Nentjes, 2003). Even with differing abatement costs across the globe, the impact of eliminating one ton of CO_2 has a uniform impact everywhere, so having "flexible" emissions reductions across borders wouldn't diminish the overall impact on climate. What's more, with optimal use of marginal cost differences and market mechanisms, the overall costs of combatting climate change would be reduced by as much as 80% compared to singular, domestic action (Richels, Edmonds, Gruenspecht, & Wigley, 1999).

In order to formulate accurate and effective flexibility mechanisms, COP1 had launched a pilot program in 1995, Activities Implemented Jointly (AIJ), in anticipation of kinks in the design process. The AIJ system allowed Annex I countries to implement projects in other countries that reduced emissions or enhanced carbon removal through sinks. Being a pilot project, the actions taken under AIJ didn't count toward emissions commitments taken at Kyoto. However, AIJ projects were reported and recorded carefully, offering the UNFCCC and international negotiations a basis for analysis of effectiveness and financial justification for investment in projects (Dinar, 2013). AIJ provided a baseline experience for countries who were dealing with this type of international project design, offering insight into thorny issues like project approval and transaction costs (Dinar, 2013).

The hard details of the Kyoto flexibility mechanisms were not flushed out at Kyoto's conception at COP3, but were formulated over time with the aid of the Second Generation Model (SGM), launched in 1998. The SGM modeled economic activity, energy consumption, and carbon emissions for twelve world regions. It provided estimates of future time paths for economic activity, associated emissions, and the economic costs of abatement (Dinar, 2013). The SGM's conclusions were intended to inform the structuring of the flexibility mechanisms. Not surprisingly, the SGM estimations made a very strong economic case for immediate, long-term action as opposed to delayed but shorter-term action. Additionally, for regions/countries that were more reliant on fossil fuels for energy or export, the SGM argued those regions would have considerably higher abatement costs (Sands, 2004). After undertaking the comprehensive economic analysis, it's complexity demonstrated to scientists the necessity of accurately tuning climate models to shifts in economies, supply, demand, and technology in order to evaluate market clearing price points and emissions thresholds (Dinar, 2013). The SGM system built understanding around what obstacles laid ahead, where the most difficult places for emissions reduction would be, and what tuning needed to happen with climate trajectories and abatement cost models (Sands, 2004).

The groundwork laid at Kyoto, built through the SGM and AIJ, and finalized at Cop7 in Marrakesh, Morocco in 2011 resulted in three flexibility mechanisms to be put to use during the commitment periods: International Emissions Trading (EIT), Joint Implementation (JI), and the Clean Development Mechanism (CDM). All three of these established carbon markets that traded AAU's to assist in meeting their protocol commitments. Creating carbon markets had originally been a highly contentious point of Kyoto discussions. The US have been largely in favor of trading and was outspoken as one of the largest proponents (Cass, 2006). Some EU countries had bee verbally opposed. Other industrialized nations, like Japan and other EU members, were in favor but hesitant, wanting to ensure that the US would not use political leverage to gain preferential access or economic power to exploit other, less wealthy countries (Grubb, 2016). These debates were long-lived in the discussions that followed Kyoto's conception, but agreement was reached in Marrakesh and with it came the initiation of three unprecedented international market mechanisms.

International Emissions Trading (IET)

Based on a country's emissions and committed reductions, that country was allocated a quantity of AAUs that constitutes an emissions ceiling – that ceiling equals how many tons of carbon it can emit and still meet its reduction goal. If any Annex B country surpassed its emission reduction goal and shot below its ceiling, the excess AAUs could be sold to other Annex B countries that required them through the IET. In this way, a carbon market was formed and units of emissions were traded back and forth based on demand and supply. By starting with an emissions goal and working downward from it with reduction, IET was considered a top-down approach to mitigation (Woerdman, 2000). For some countries, IET could add buffering to their emissions targets if they weren't proactive enough; for others, the opportunity to profit from proactive action could reinforce even greater mitigation (a country was limited in how much it can sell, as to minimize the laziness of rich countries that buy credits). Countries that were resistant to the mechanism worried the possibility of "hot air" emissions reductions. This "hot air" notion was relevant to countries like Russia, who by nature of their bleak political situation and the dissolution of the Soviet Union, were bound to see their emissions impacted and could utilize this coincidental reduction to profit by undershooting trajectories that didn't account for an economic slowdown (Khovanskaia & Ivanyi, 2007).

The resolution, which was agreed at COP6 in the buildup to Marrakesh (COP 7), was to shift from the original, money-for-credit exchange. Instead, participating countries voluntarily took part in the "Green Investment Scheme" (GIS), which upheld that trading between countries would be doubly beneficial to environmental investment. Under GIS, when a country sold AAU's to another, the recipient's revenue would be reinvested at some later date into projects or purposes that lowered GHG emissions or raised environmental protection (Karásek & Pavlica, 2016). In this way, trading among countries maintained integrity in its impact on the environment and lowered paranoia over "hot air" benefits.

Joint Implementation (JI)

Unlike the EIT top-down approach, the JI approach worked from the bottom-up, *adding* reductions as a project-based mechanism rather than subtracting (Woerdman, 2000). Annex B countries invested dollars in projects in other Annex B countries that either reduced emissions or enhanced sinks. For however large the resulting emissions reduction was for the project in the "host" country, the equivalent quantity of emissions units would be awarded to the "investing" country as "Emissions Reduction Units" (ERUs), which were measured as a per unit equivalent to AAUs. Implementation and monitoring was fairly straightforward because all Annex B countries had existing emissions caps and national guidelines for emissions measurements related to projects (Dinar, 2013). Rewarding the ERU's was the responsibility of the Article 6 Supervisory Committee, who ensured that the achievement of ERU's was consistent with "additionality." "Additionality" applied to projects means the project's emission reduction impact would not have occurred otherwise given a country's political or economic activity, hence, it is "additional." In this case, additionality is achieved if the emissions pathway post-project is less than the host country's original, baseline emission trajectories (Erickson, Lazarus, & Spalding-Fecher, 2014). The baseline for a country's emissions, without a concerted effort to reduce them, is called its "business-as-usual" trajectory. Because the judgment of additionality is based on this business-as-usual prediction, host countries have incentives to overestimate their baseline emissions, allowing more projects to seem additional and attracting more investment. On the flip side, if a country happened to underestimate their emissions, the Supervisory Committee may not grant additionality to a worthy project, due to the seemingly low emission pathway the country already predicted for itself (Woerdman, 2000). The same goes for measurement of project impacts: both the host country and the investing country are incentivized to raise the estimated impact of a project; one hopes to gain more credits, the other hopes to gain more investment. If a truly non-additional project were to be deemed additional, there would actually be a *net increase* in emissions because the award of false ERUs diminishes the need for domestic emissions reduction in the investing country (Tewari, 2015). Understanding this, Kyoto required third party monitoring for baseline trajectory modeling, as well as project reduction estimations (Woerdman, 2000). The overall hope with JI is not only monetary benefits and growth, but also the transfer of critical technology.

<u>The Clean Development Mechanism (CDM)</u>

The CDM was the cornerstone of the flexibility mechanisms, largely due to its potentially far-reaching impact on long-term emissions stabilization. The purpose of the CDM was to allow non-Annex I countries to further economic development while simultaneously fulfilling emissions stabilization and reduction. Like the JI, the CDM was a bottom-up, project based mechanism, and functioned almost entirely the same, except for one factor: in the CDM, Annex B countries invested in projects in *non*-Annex I countries. By investing, Annex B countries received Certified Emissions Reduction credits (CERs) equivalent to AAUs that contributed to meeting their emissions ceilings. By investing in emissions reducing projects in developing countries, there are the dual benefits of climate change mitigation and development. Two critical climate science principles were captured with the CDM, meeting the need to leverage private investment capital and recognizing that many of the best climate change mitigation opportunities were in poor countries (Dinar, 2013). Contrasting the JI, the CDM acted on the fact that abatement costs in wealthy, industrialized countries were often high so creating opportunities in low-income countries with lower abatement costs would attracted investors (Dinar, 2013). For the CDM, it was a particularly attractive idea to replace impending fossil fuel-based growth in developing countries with renewable energy or low-carbon growth options. Each project fell into any of seven categories, ranging from energy efficiency to transport to N_2O reduction (Jacques, Guan, Geng, Xue, & Wang, 2013). Later on in the negotiation process, the category of land-use, land-use change and forestry (LULUCF) was added, but was restricted to comprising at most a fifth of a party's needed reductions. Because technical resources for measuring emissions reductions in Annex I countries were not as readily available in non-Annex I countries, the approval process for projects was very meticulous, requiring 7 steps of registration and tight monitoring (Koike, 2011). Having a heavily regulated program was important for keeping countries accountable for their actions; discussion for fine-tuning these rules was necessary for agreement in Marrakesh. The CDM has ambitious aspirations, and ideally would cover the bases of cutting global emissions, transferring useful technologies and slashing mitigation costs for developing funders.

Compliance Mechanism

A compliance mechanism was created for the Kyoto Protocol with intentions to strengthen the integrity of the Protocol, support carbon market's credibility, and ensure transparency of accounting by Parties (UNFCCC, 2014c). To enforce compliance, failure to meet first period commitments automatically initially disqualified a country from participating in the emissions trading mechanism with further penalties for continued non-compliance (UNFCCC, 2014c). This was one of the most rigorous and comprehensive systems for a multilateral environmental agreement in history (UNFCCC, 2014c), and also became one of the most highly contested points before completion at Marrakesh (Grubb, 2004). Countries felt they could not rescind commitments after ratifying if they wanted to and many uneasy nations sought concessions and outlets in case of failure (Grubb, 2004). In some ways, this influenced the use of flexibility mechanisms, whose initial designs were oriented around free-market demand and supply. With heavy-handed encouragement by Kyoto, the mechanisms couldn't be considered unadulterated litmus tests of market preferences because they became more of a necessity for achieving commitments.

Ratification

The Kyoto Protocol was adopted by COP3 on December 11, 1997, expected to be open to signature on March 16, 1998. The Protocol had a process that first required national leadership signage and *then* ratification through a more thorough process. Directly following the monumental negotiations, all parties seemed relatively set to accept the deal as a reasonable compromise that preserved the essential elements required to tackle the problem (Grubb, 2004) with some details around components like financial mechanisms pushed back. The Clinton administration of the United States signed on November 12, 1988. Regardless of the fanfare around signing the agreement, President Clinton knew very well the US senate did not favor the deal. A year earlier, following the formation of the Kyoto Protocol at COP3, the senate had released its verdict on US participation through the Byrd-Hagel Resolution:

"Because of the disparity of treatment between Annex I Parties and Developing Countries and the level of required emission reductions, [Kyoto] could result in serious harm to the United States economy, including significant job loss, trade disadvantages, increased energy and consumer costs, or any combination thereof (The Senate of the United States, 1997);"

Economic concerns were overbearing and the congressional resolution had passed 95-0 with unanimous, bipartisan support. What excitement had been built up around Kyoto had come crashing down to reality, given the US's status as the globe's largest emitter, and the President quickly urged alterations in Kyoto that would garner support for ratification. The factors that had needed to be fixed for US satisfaction were relatively clear. Policymakers stressed the economic consequences of mitigation policies (Bang, Tjernshaugen, & Andresen, 2005), so easing emissions burdens or reducing economic impact would be key. Policymakers cited the "disadvantage" from developing countries being exempted (Bang et al., 2005), so adjusting mandates could also gain the senate's favor.

With the proposition of various US self-interested alterations, debates around the nature of the agreement and its components were fierce between nations. This generally divided into two large blocks, the EU on one side, whose attitude stressed emission reductions at any cost, and the Umbrella Group opposing (the US, Australia, Japan, Canada, and others) who argued for a decreased emissions reduction burden (Cass, 2006). It was hoped that final details could be settled at COP 4 in Buenos Aires the following year, but agreement fell flat. Ratification began with a ceremonial signing by Fiji as countries scrambled to find agreement. The Protocol was to enter into force under two conditions: if ratification garnered support equal to 55% of total 1990 carbon dioxide emissions from Annex I counties *and* if it got at least 55 Parties' acceptance. (UNFCCC, 2014e) Achieving 55% of global emissions would be no small task if the world's largest emitter, the US, was not committed. With COP4 recognizing its failure, an agenda was built for issues to be resolved two year later in 2000, at COP6 in The Hague, Netherlands.

Two years of planning between governments and their respective bodies of scientists and social scientists came to a head in COP6 but in the end, unfortunately, deliberation yielded no fruition (Grubb, 2004). The three points of failure for agreement were 1) the rules for the flexibility mechanisms 2) accounting for carbon sinks (LULUCF) and 3) developing countries commitments. The EU intended to limit the use of mechanisms in the industrialized world; the Umbrella nations wanted heavy inclusion of such mechanisms, citing them as major contributors to the countries' ability to meet obligations and minimize costs (Cass, 2006). The Clinton administration was very explicit in its support of the mechanisms, echoing congress by expressing that emission reductions anywhere mattered equally for the globe (Cass, 2006). Conversely, the EU and others warned that overuse of mechanisms would warrant too little domestic action; the mechanisms were designed to be "supplemental," not strategies for cheating obligations (Cass, 2006). In the end, all three proposed mechanisms were included, but the agreement stressed they remain supplemental.

The US also wanted the inclusion of large countries like Brazil, China, India, South Korea, Mexico and Brazil in commitments to compensate for the reciprocal "disadvantage" to Annex I countries. Although the EU was willing to cooperate on this issue, the developing countries wouldn't budge. What ensued was a debate between countries with accountable histories (developed) and promising futures (large developing) (Cass, 2006). Ultimately, the developing countries got their way and remained peripheral in relation to Annex B commitments, abiding by the IPCC and UNFCCC's founding principles concerning historical contribution to the impending crisis.

The US and Umbrella group pushed for carbon sinks, like forests and proper land practices, to play a larger role in emission counting than the EU permitted, ringing true to the US's consistent attempts to decrease the ratio between the amount of emissions reduction achieved and the amount of work required to do so (Cass, 2006). The largest benefactors of LULUCF inclusion would be countries with the most endowed forest and farmland sinks, like the United States, whose motive was transparent. Beyond the political debate, scientific barriers existed for sink removal measurement. The proper implementation of LULUCF accounting for emission reductions was key to not over-rewarding such activities and offering an unfair advantage to certain countries (Liu et al., 2016). Some generous calculation methods of forest and soil sequestration, when aggregated globally, were so overstated that they completely offset required reduction by the Kyoto Protocol altogether (Cass, 2006). The US intentions were very transparent– diminish their actual requirements by as much as possible.

Following stagnant negotiation at The Hague, spurred largely by US impediment, the parties then witnessed the entrance of US President George W. Bush in the 2000 US election, an outspoken critic of the Kyoto Protocol due to cited, "large economic disadvantages." A fundamental pillar of his campaign had been reformation of the national energy strategy, which sought energy independence through expansion of domestic fossil fuel production (Cass, 2006) and clearly ran contradictory to Kyoto's objectives.

Coincidentally, following his entrance into office in 2001, the IPCC's *Third Assessment Report* (TAR) was released and provided even stronger confirmation of anthropogenic climate change. The TAR had "robust" findings for observed warming of the earth's surface attributable to human activities, with increased confidence around temperature increases, sea rise, and heat wave frequency (IPCC, 2001). In response, seeking a more independent outlook, the executive branch of the US federal government requested that the US National Research Council provide a climate science assessment for federal review. The report concurred with most of the IPCC's statements, echoing that climate change was occurring and anthropogenic (US NRC, 2001). In the face of an overarching, global scientific call for action and the echoes of a secondary, nationally produced confirmation, in March of 2001, the Bush Administration of the United States publicly rejected ratification of the Kyoto protocol, provoking fallout (Grubb, 2004). In a published statement on the decision, the Bush Administration conceded that CO_2 caused warming, that warming was increasing, and that human-induced climate change existed (Bush, 2001), but then maintained that future considerations of international agreements must consider developing countries like China and India "whose net greenhouse gas emissions now exceed those in developed countries (Bush, 2001)." According to the Bush Administration, complying with the "arbitrary mandates" would have had a negative economic impact "with layoffs of workers and price increases for consumers (Bush, 2001)." With the refusal to join, the US had pronounced the Kyoto Protocol "dead" (Egenhofer et al., 2008).

The Bush Administration and the US received strong backlash. At the time of withdrawal, polls showed that 61% of the American public supported ratification (Cass, 2006). International partners expressed their sharp criticism of the US decision – the US had clearly squandered influence in the realm of international climate negotiations (Cass, 2006). The US alleged it would find an alternative the Protocol, but an alternative of the same magnitude was unlikely (Grubb, 2004). Ironically, following the US withdrawal and declaration that the agreement was "dead," the remaining parties committed to swifter deliberations and completion of the agreement. Most of the items the EU had fought against in the early stages of negotiation were included for the sake of ratification (Cass, 2006). The inclusion of LULUCF in the agreement also occurred, meaning total reduction efforts would equate to only 1.8% in actual reductions, rather than the intended 5.2%, (Cass, 2006), in a massive hit to the Protocol's actual impact on emissions levels.

There was a laundry list of ironies emanating from the US decision to withdrawal. First, the US was in essence rejecting it's own treaty. The Kyoto Protocol was largely shaped by the whims of the Unites States, and many countries had made concessions on account of US participation (Grubb, 2004). The Bush Administration had claimed that he was rejecting "Clinton's" treaty but in reality he was rejecting the world's treaty, which had reached global consensus and dictated other countries actions (Grubb, 2004). A second irony was that US rejection had actually resulted in cooperation from the EU and other countries to re-invigorate the global initiative. Countries that had once bickered over the correct amount of mitigation turned to cooperation for the sake for ratification (Grubb, 2004). Third, the response by the domestic US was resounding; California enacted vehicle emissions standards, 10 New England states implemented CO_2 trading systems, and a coalition of clean energy funds were created across 14 states (Grubb, 2004). What completed the ironies was the fact that, with US withdrawal, implementation became cheaper and easier for everyone else, by eliminating the largest demander of emissions trading credits within the flexibility mechanisms (Grubb, 2004). The original costs for meeting mitigation commitments was estimated as 0.1-1.1% (0.2-2.2% without flexibility mechanisms) of Annex I GDP by the TAR, but after adding US rejection and flexibility mechanisms, the cost was estimated as less than 0.05% (0.1% without flexibility mechanisms). US withdrawal, caused by economic interests, had incidentally made Kyoto much more economically practical.

The Kyoto Protocol, an agreement monumental in its precedence and mission, had devolved from a very strong agreement to one much weaker than global negotiators intended. Its ratification came on the 16th of February, 2005, when Russia, who was formerly ambivalent before US withdrawal, pushed total commitments beyond the needed 55% threshold. Russia had been increasing its emissions since the 1990s and was keen on taking advantage of the Protocol's trading mechanisms (Walsh, 2004), as to not fall behind it's other participating European rivals. This emphasized a valuable principle in climate negotiations – if everyone joins the club and reaps the benefits, countries like Russia would be remiss to void participation. By joining as a last major emitter needed for ratification, Russia had filled the shoes left vacant by the United States and pushed forward the international climate change agenda. Finally, the coalescing of determined science and diplomatic negotiations had yielded action on a global scale, and suddenly climate change became an action item tackled by cooperative, multilateral agreement and participation. Anticipation for its subsequent results was very high, and only time would tell of its effectiveness.

Post-Kyoto Ratification

In the same year that Russia ratified Kyoto, the first annual Meeting of the Parties (MOP 1) was held in conjunction with COP 11 in Montreal. The MOP arm of the conference was restricted to ratifying members of the Kyoto Protocol and was a platform for continued negotiation and refinement of processes. COP/MOP 1 initiated discussion around the second stage commitments for post-2012 Kyoto (Egenhofer et al., 2008).

Soon after, in January of 2006, the Asia-Pacific Partnership on Clean Development and Climate (APP) was formed by Australia, China, India, Japan, South Korea, and the United States, describing a shared vision to “advance clean development and climate objectives… The Partners will enhance cooperation to meet both… increased energy needs and associated challenges, including those related to air pollution, energy security, and greenhouse gas intensities, in accordance with national circumstances (APP, 2006).” The APP encouraged technology transfer and collaborative project building to reduce emissions and spur environmentally friendly project growth. This was a formative step in wealthy countries taking initiative – member countries accounted for over 50% of the world’s greenhouse gas emissions. Only two months prior, the landmark Stern Review had assessed the cost of climate change damage to be as much as 20% of GDP, but only 1% if acted on proactively ("The Stern Review on the Economic Effects of Climate Change," 2006). The APP demonstrated that countries were beginning to realize not only the ethical and environmental cases for climate action, but the economic case as well, a dramatic shift in thought for the United States in particular, who had so recently rejected the Kyoto Protocol on the basis of economic interest. Although the APP only lasted until 2011 before being retired, the commitment demonstrated an evolving international partnership mentality around climate change that had been born from and complementary to the efforts of the UNFCCC and Kyoto Protocol (Egenhofer et al., 2008). Its formation had mimicked the cooperative nature of both the Kyoto and Montreal Protocols, but interestingly enough had one resounding characteristic that differed – all actions within the APP were on a voluntary basis. Encouraging voluntary commitment, rather than mandatory action, was a shift in thought for conventional climate change mitigation, and demonstrated that mitigation actions were becoming less burdensome and discouraging economically. Although the APP was short-lived, it still offered an inventive conceptualization that that would eventually become a standard.

<u>Bali</u>

In 2007, COP 13/MOP 3 was held in Bali, Indonesia. Much of the discussion revolved around the recently-released IPCC *Fourth Assessment Report* (AR4), which had magnified urgency and stated that climate system warming was "unequivocal (IPCC, 2007)." AR4 was 90% certain that emissions from greenhouse gasses were responsible for the modern-day climate change (IPCC, 2007). Inducing global alarm, many negotiators believed even the most reluctant parties would cooperate in the face of the report (Clémençon, 2008). Compounding this, a month before talks in Bali the

IPCC was awarded the Nobel Peace Prize, together with former United States Vice President Al Gore, who earlier that year had released the provoking film "An Inconvenient Truth" that captivated the public and commanded attention to the climate change issue. The momentum leading into the conference yielded effective negotiation and a conference product called the *Bali Roadmap* that provided guidance for a new, post-Kyoto climate agreement. The *Bali Roadmap* outlined comprehensive processes for long-term cooperative action through it's *Bali Action Plan*, which focused its attention on four items: mitigation, adaptation, technology transfer, and finance (Clémençon, 2008). The *Bali Roadmap* and *Action Plan* expected a post-Kyoto replacement to be adopted at COP 15 in Copenhagen, Denmark in 2009, two years later (UNFCCC, 2014a). After hiatus, the United States returned once more to the international climate negotiation table (Clémençon, 2008). The agreement was finalized through sufficient consensus and the *Bali Road Map* set the stage for the next multinational agreement on climate action.

Bali also yielded helpful discussion for the UNFCCC and COP's economic mechanisms. Conversation expanded about the CDM, helping chart its course of continuous development and flaw correction. The CDM had experience high utilization in the years building up to Bali, and reflections on the ability of the CDM to be a key instrument in producing co-benefits of growth and mitigation were generally positive (Clémençon, 2008). The emissions trading scheme was an item of discussion, as the role that it could play in future agreements was shaped. Although the mechanisms of Kyoto were in their early stages of use and lacked results, it was clear that similar mechanisms would be important to the next major climate agreement, do to there ability to decrease abatement costs and increase low-carbon investment in developing countries.

The Adaptation Fund was finalized in Bali. Adaptation didn't have the attention that mitigation had controlled with the UNFCCC and Kyoto Protocol in 1997, but its importance had quickly grown since then as the gravity of climatic impacts began to take hold in vulnerable developing countries and island nations (Clémençon, 2008). The addition of "adaptation" into the four primary pillars of the *Bali Action Plan* demonstrated its expanding significance, and the subsequent creation of The Adaptation Fund was its first tangible outcome. The Adaptation Fund was intended to increase adaptive investment in the countries of greatest vulnerability, with hopes of provide protection proactively rather than retroactively. The parties of the COP decided to side step donation-based funding – the Adaptation Fund would receive its funding as a 2% levy charged on all transactions under the CDM. In this way, all funds directed towards developing countries maintained consistent investment objectives.

The *Bali Action Plan* also established a program called "Reducing Emissions from Deforestation and Degradation" (REDD) intended to target deforestation. The program provided economic incentives for the prevention of deforestation, which is an issue that accounts for roughly 20% of anthropogenic emission worldwide (Clémençon, 2008). Controlling deforestation, both legal and illegal, through REDD could, in theory, be done with the correct amount of compensation and at an extremely low cost, while simultaneously doubling the income of people in forested areas and avoiding millions of lost dollars to fire-damages (Clémençon, 2008). This would operate similarly to the CDM; developed countries would contribute investment dollars to compensate certain areas populous' for halting deforestation, and in return, countries would gain the equivalent amount in emissions reduction credits. The World Bank announced its support for REDD in Bali, backing the launch with $250 million for assessing the carbon value of forests in developing countries and, if applicable, contributing to offsets. In tandem, nine industrialized countries offered an additional $165 million (Clémençon, 2008), putting wind behind the sails of the new mechanism. Even so, the idea was young, and there remained large questions around measurement accuracy and the complexities of the convoluted payment system. Some argued that providing economic incentives could actually *increase* deforestation, as populations may damage forests out of the interest in monetary "corrections." Others argued that an afforestation strategy was not sensitive to indigenous cultures that lived sustainably off of forested lands (Clémençon, 2008). Although it was not perfect at its conception, REDD was still seen as a creative and successful step towards combatting deforestation policy (Clémençon, 2008). This REDD conception was an analogy largely representative of the greater Bali COP; although very little concrete product came of it, the wheels had been set in motion. Bali set the stage for another agreement, expected in Copenhagen two years later, that captured the benefits of economic mechanisms, set new targets for action, and answered the growing realization that the window of opportunity on climate action was rapidly getting smaller.

Copenhagen

From initiation, it was clear with Copenhagen that negotiation progress would be sluggish. The optimism born out of Bali was not rewarded with tangible solutions, the great recession of 2008 had captured the full attention of policy makers, and the prospect of a globally binding agreement was bleak. Just weeks before COP 15 in Copenhagen, the UN Secretary-General Ban Ki-moon admitted that an agreement would most likely not be achieved and the best that could be hoped for was voluntary reduction targets (Nagtzaam, 2010). It was now clear that Kyoto's legally binding commitment structure would not be repeated, and in its place would be a weaker, "politically binding" agreement, matching the structure created by the APP three years prior.

Just days before the conference, a slew of hacked emails between climate researchers were released to the public depicting scientists pushing forward bias and committing malpractice in their research efforts to prove climate change existed. The news exploded, and global reports of "Climategate" ensued. Ultimately, the pieces of "evidence" released were taken out of context and served no basis for malpractice in the scientists' research processes. The damage, however, remained, and a tensions bubbled between climate change skeptics and believers. The integrity of climate research was confirmed by third-party scientific groups and an independent investigation, but Copenhagen was nonetheless overshadowed by the political controversy – an unfortunate foreshadowing for the impending failure of the agreement itself.

Once the conference was finally underway, it was clear that progress would be very slow. Very little was accomplished quickly as countries failed to reconcile differences on critical topics (Nagtzaam, 2010) like the 2° temperature target and developing countries' emissions reductions. With gridlock and negotiation standstills, Copenhagen talks ultimately produced no tangible agreement the night before what was supposed to be a monumental signing. Pushed into panic mode, the US and the BASIC countries (Brazil, South Africa, India, China) bypassed the democratic process and assumed control, writing an agreement overnight to be signed by the various heads of state the next day.

The final draft of the Copenhagen Accord, in many ways, resembled the *Bali Road Map* as merely a suggestion for further action. It argued that deep cuts in emissions were critical, but not worth sacrificing development and poverty eradication in developing countries (UNFCCC, 2009). This central tenant was indicative of the BASICs negotiation victory by upholding the principle that less-developed countries had the right to grow. The accord demanded urgent adaptation action in highly vulnerable countries, referencing the newfound Adaptation Fund as an important resource (UNFCCC, 2009). A mechanism called the Copenhagen Green Climate Fund was created to be supplementary to the Adaptation Fund, facilitating "technology development and transfer." Details about its function were slim but the idea spawned excitement (Nagtzaam, 2010). REDD was also finalized and adopted after its conception in Bali, set to begin afforestation efforts in developing countries. Beyond all of these factors, perhaps the most profound element of the Copenhagen Accord, setting the tone for future agreements, was its explicit shift from mandatory obligations to voluntary ones. This was primarily due to self-interested participants like the United States, who hoped to make emissions commitments more comfortable (McGee & Steffek, 2016). By putting this structure into writing, the bottom-up model had overruled the traditional top-down model of emissions reductions (Lattanzio, 2014; McGee & Steffek, 2016). Copenhagen's commitments were far from serious, more focused on "showing each country what each other is doing" as mutual encouragement, and there was no backbone making commitment necessary (Nagtzaam, 2010). The accord stated that its objective would be to limit temperature increases to 2°C, ideally 1.5°C. Although this was ambitious, no timetable was included for when that goal was to be met or how it would be achieved (UNFCCC, 2009). Ultimately, the accord had very little concrete product.

In the end, most states supported the Copenhagen Accord as a key step towards a better, future agreement (Nagtzaam, 2010). Even so, UN consensus failed: Sudan, Venezuela, Bolivia, Nicaragua, Cuba and Tuvalu refused to accept the document. The meager resolution was to instead "take note" of the Accord, a motion that gave the Accord legal status to be operational but without the need for the Parties' approval. The resulting agreement had optional commitments and was now doubly optional for recognition, reinforcing the new, "voluntary" approach. With only a modest backing and no surrounding enthusiasm, no parties elected to take on authority of the agreement. This served as affirmation that there would be no COP15 replacement for Kyoto, and although Copenhagen was a step in the right direction toward a prospective replacement, it ultimately pushed any actual decision making down the road.

The world's reactions were mostly negative, and Copenhagen has been colloquially referred to as a failure, but opinions were spread across the board – some optimistic for the future, some disappointed in the non-binding nature, and some satisfied with specific provisions (Nagtzaam, 2010). No matter, it was true there were objectively positive takeaways: Climate change negotiations had never received such an engaged, global audience, complemented by public demonstrates in the city of Copenhagen calling for climate action. The BASIC countries had played their largest role in negotiations yet, making a strong introduction for developing countries into the international climate arena that was needed for effective long-term negotiations. Additionally, private funding had been accessed for adaptation and mitigation globally, supplemental to intergovernmental activities. The common themes of failure were around schisms: The standoff between developed and developing countries continued to be a familiar debate, and the small "clubs" like the BASIC countries had abandoned a multilateral approach in favor of getting a written deal completed. In the end, it was clear many policy makers indeed cared more about the current financial crisis than the long term climate crisis (McGee & Steffek, 2016). When considering the strong tailwinds leading into Copenhagen that had gone to waste, the UN General Secretary spoke accurately: “We should have done better (Nagtzaam, 2010).”

Cancun

A year later, in December of 2010, COP 16 in Cancun was held. This conference would be remembered for its proposed “paradigm shift towards building a low-carbon society that offers substantial opportunities and ensure continued high growth and sustainable development (UNFCCC, 2010).” The focus on the growing concept of sustainable development was stronger than ever before, particularly concerning technology transfer and research. The notion of “equitable rights for sustainable development,” enlarged the concept of equity beyond traditional “burden sharing (UNFCCC, 2010),” it mandated cooperative climate action that simultaneously addressed global and national development issues (Hourcade & Shukla, 2015). Helping developing countries seek “low-carbon” transitional growth aligned carbon limiting practices favored by Annex countries with the development ambitions of non-Annex I countries, and argued that this low-carbon strategy offered co-benefits like energy security, energy access, decreased urban air pollution and increased quality of urban life (Hourcade & Shukla, 2015). It was hoped that through a shifting international paradigm, the debate between ‘climate first’ and ‘development first’ would no longer be a zero-sum game. Of course, this mean that the role of investment needed to expand, especially as the global climate regime altered its approach towards voluntary, self-determined commitments that were no longer guaranteed (Hourcade & Shukla, 2015).

To address the growing emphasis on sustainable development, high-income countries at Cancun jointly pledged up to $30 billion in "fast-start" climate financing for developing nations for the period 2010-2012 with a future objective of offering a joint $100 billion annually by 2020. The COP also officially rolled out the Green Climate Fund (GCF) after it's quiet introduction in Copenhagen. The GCF finances climate change action in developing countries, either through mitigation or adaptation measures (Hourcade & Shukla, 2015) as a complement the existing multilateral climate funds like the Adaptation Fund and Global Environmental Facility (Lattanzio, 2014). It was designed to be arm's length away from the UNFCCC, and under the guidance of the Conference of the Parties, with the World Bank serving at its trustee. It allowed investments to come from developed countries, as well as private sources (Lattanzio, 2014). The details and mechanics of the GCF were to be worked out by The Transition Committee over the coming years (UNFCCC, 2010), with eventual adoption at COP 17 in Durban in 2011 and full operation in the summer of 2014. Following all of this progress at Cop 16 in Cancun, the first period of the Kyoto Protocol was set to end two years later, in 2012. In the buildup to COP 18 in Doha, which sought to finalize commitments for the second period of Kyoto, nations reviewed the progress made over the first period.

The Results of Kyoto

The views of Kyoto's effectiveness were, and still are, thoroughly mixed. From a positive perspective, compliance was as strong as it could've been. Of the 36 countries with commitments to reduce emissions, only 9 did not reduce domestic emissions (Shishlov, Morel, & Bellassen, 2016). However, those 9 countries utilized flexibility mechanisms to meet their emission goals, meaning that, even in the face of skepticism, Kyoto had received 100% compliance by participating parties (Shishlov et al., 2016). Overall, 36 countries reduced emissions by an aggregated 4%, marginally below their commitment of 5%. Amazingly, economies in transition decreased their emissions by an astounding 38%, and claimed that it had been done with minimal effect from "hot air" emissions reductions (Grubb, 2016). Reductions had strong contributions from flexibility mechanisms, which had helped 9 nations to meet their goals, but also confirmed the EU's paranoia that mechanisms would warrant less domestic action. Although measurements of Kyoto's emissions reductions were very convoluted, and exact numbers were rough in their estimation, it was generally agreed that substantial progress was achieved in the way of iterative risk management (Grubb, 2016). Of total reductions, LULUCF accounted for somewhere around 8% (Liu et al., 2016), a large contribution when considering that it's provision was nearly not included in the Protocol except for the beckons of the United States. At the core of reduction efforts, not surprisingly, was the EU-15, which reduced its emissions by 10% below 1990 levels (Grubb, 2016). One empirical study argued that for countries that had commitments, the agreement produced 10%

less CO_2 emissions compared to the "business-as-usual" counterfactual of "no-Kyoto (Aichele & Felbermayr, 2013)." Another claimed 7% (Grunewald & Martinez-Zarzoso, 2016), supporting that Kyoto may have non-negligible effects.

The so-called "100% compliance" negates the fact that 32 countries faced emissions commitments while 138 did not (Grunewald & Martinez-Zarzoso, 2016), including the major emitters of the United States and Canada. Canada's withdrawal came in 2011 with the argument that US non-participation had left Canada unreasonably exposed. In truth, Canada hoped to escape being labeled non-compliant by the emissions measurement that was only weeks away (Grubb, 2016). Although all Annex B countries had in fact met their commitments, some studies argued that, when accounting for changes in foreign trade and the subsequent "displacement" of emissions to developing countries that produce goods for export, total Annex B emissions had actually increased, not decreased (Kanemoto, Moran, Lenzen, & Geschke, 2014). The large increase in imports and "embodied" emissions in Annex B countries over the first commitment period attested to the intense consumptive nature of developed countries, as the discrepancy between Annex B's territorial emissions and their actual carbon footprint grew (and continues to) (Kanemoto et al., 2014). For most developed countries, from 1990-2012, transfer emissions rose dramatically, anywhere from 2-8% (Yang et al., 2016). This was across all emissions, no only restricted to embodied CO_2 (Kanemoto et al., 2014). What is perhaps most illustrative of this continuing phenomenon is that many of the very sectors that are reducing their emissions levels most significantly in developed countries during the Kyoto period were simultaneously seeing reciprocal increases in their import levels (Kanemoto et al., 2014). This could explain the current reduction trend in Annex I industrial emissions, as large swathes of industry continue to be transferred to developing countries (Liu et al., 2016). In nations like China, production for export has accounted for as much as 30% of annual emissions in recent years (Kanemoto et al., 2014). Because the Kyoto protocol only measured territorial emissions, burden shifting became an issue worth addressing in future agreements. Adding to criticisms of Kyoto, many skeptics also pointed to the global economic downturn faced in 2008 that had substantial effects on national production and contributed to a higher rate of compliance (Grubb, 2016).

Results of Flexibility Mechanisms

The results of Kyoto were important for crating discussion around the flexibility mechanisms. Analysts dug into what economic sectors and projects had been the most attractive, what worked well, what didn't work well, and how the mechanisms should differ in the future. The CDM saw the most success of the three, with strong activity towards global renewable energy capacity growth, particularly in Asia (Grubb, 2016). As of the beginning of 2018, 7,789 projects were registered for use. Of those projects, 60% were large scale and 40% were considered small scale (Rocamora, 2017). The two dominant project types were hydropower and wind power, each contributing 24% of the total CDM emissions reductions and solidifying renewable energy as a viable sustainability measure. The CDM was much more heavily adopted by industrialized Annex I countries than less developed Annex I countries, demonstrating that mechanisms were more accessible to those with wealth (Dinar, 2013). CDM adoption was also higher for countries that had lower renewable energy sources at the onset of the commitment period. Clearly, parties that were not already taking domestic action, or had sufficient wealth, could push their emission reduction contribution onto other countries through investment (Dinar, 2013). For hosting, just six host countries accrued over half of all CDM investments, demonstrating the lack of universality that the mechanism hoped for. CDM adoption was also higher for parties that had more experience with the AIJ pilot, suggesting a learning curve for project-centric mechanisms that could hopefully be acted on in following agreements. Interestingly enough, because of the CDM's interaction with LULCF, a reflection of LULUCF's progress showed in was intensely underutilized, in part due to the CDM's convoluted structure and deterrent transaction costs (Dinar, 2013). Studies found that the return on LULCF projects for period one were much higher than expected, expounding it's reputation as a missed opportunity.

There were many questions about the CDM that were asked by policy makers after the first period was complete. In many countries, there were certain project's technologies and strategies had already been financially backed by their respective governments, and this sparked arguments over additionality. China, for instance, had implemented the most CDM projects of any country, specifically those of hydropower, a technology that already garnered generous government support. It could be argued that, counterfactually, that many of the hydropower projects would've been built regardless (Erickson et al., 2014). Wind power also fell into the same debate, being a notably cheap and efficient energy source backed by governments (Erickson et al., 2014). Other questions arose when aggregated data on the CDM showed that after the registration processes, CDM projects only received, on average, 27% of their potential max mitigation impact (Tewari, 2015). This meant that a majority of projects were not receiving the amount of credits they were designed to create, questioning additionality because the projects continued to be fully funded. When emissions credits aren't being received, the only other possible motive for project creation would be financial return, a motive factored into calculations of business-as-usual baselines because investors perpetually seek favorable returns anyways. Beyond this, additionality questions around impact were highly critical of the CDM. Because the CDM encouraged low abatement costs and therefore the lowest-cost investment, projects that had the highest emissions reductions, in stead of the biggest sustainable development impact, were preferred, occasionally disadvantaging project localities (Watts, Albornoz, & Watson, 2015)To address this point of contention, it was recognized that future mechanisms needed stronger regulation, more thorough impact analysis, and better protection of communities' rights (Rindefjäll, Lund, & Stripple, 2011).

There were many similar lessons learned between the JI and the CDM, but the JI's overall output was less substantial. Less use was expected for the JI from the onset. For one, the JI didn't start accruing credits until four years after the CDM. Additionally, building projects in Annex B countries was more expensive than in developing countries, due to differences in things like capital and labor costs, so investments through the JI were naturally less attractive than those through the CDM. Arguing for additionality with JI projects was also tougher because most Annex B countries were actively attempting to reduce their emission already. The somewhat "typical" projects like solar, wind, and hydro, may not be as additional if already actively promoted by countries with energy initiatives and a strong financial backing. The JI only generated half the credits that were generated by the CDM, and nearly 90% of those came from Russia and Ukraine (Shishlov et al., 2016), countries that were both classified as Annex I economies in transition. This concentrated distribution mimicked the CDM's results, which had shown that CERs were primarily generated in the more advanced, developing countries. Much the JI interactions with Russia and Ukraine, nearly 85% of all CDM issued CERs came from the four large countries: China, India, South Korea, and Brazil – African countries accounted for less than 2% (Shishlov et al., 2016). It was clear that the JI and CDM converged around nations that carried characteristics of strong national growth, an absence of significant environmental initiative, and a hunger for foreign investment.

The Green Investment Scheme (updated EIT) was significant in its precedence, but from an emission reduction standpoint, its contribution was marginal comparatively. The EIT was relevant to Annex B countries only near the end of the first commitment period, when they realized their need to buy, or ability to sell, credits. Additionally, the relationship between the EU's independent EIT scheme and the JI were torturously complex, making the trading process for interested countries in Eastern Europe prickly enough to deter many (Grubb, 2016).

Kyoto's Legacy

Overall, the general sentiment was that Kyoto offered great direction, but was a failure in taking large steps to tackle climate change. This was largely a factor of its scope: a short list of countries had achieved minor reductions in their emissions, partially through mechanisms that were imprecisely monitored and poorly understood. This also was with the exclusion of the world's largest emitter, who had simultaneously increased its emissions during the first commitment period. Upon reflection, the scientific modeling that rooted Kyoto was also recognized as insufficient and called for more interaction between climate science and social science; for proper policy, countries needed to understand the relationships between the amount of emissions they produce, the subsequent contributions to climate change, and the ensuing effects on regional populations. Regardless of such negative takeaways, Kyoto still achieved its overarching goal of serving as an iterative advance in climate action worth building on. It proved that international law matters – 100% compliance meant nations took their commitments seriously (Grubb, 2016). Even though compliance and actual impact can't be justly equated, compliance sets an important precedent for the future. Additionally, the importance of the flexibility mechanisms was demonstrated. Some claimed that countries like Japan had sidestepped domestic emissions reductions with mechanism use and some host countries had dominated the receiving of investment. Although factual, the investments still spurred cost-effective, sustainable development opportunities, and helped instigate a new conception of what economic growth could look like. The outcomes of the Kyoto Protocol, both actual and perceived, did not indicate its design was a “silver bullet” formula, but the notions of international cooperation, interdisciplinary decision-making and ethical responsibility were certainly powerful. Kyoto’s flaws had been learned from and multilateral negotiation processes had benefitted; this brought hope and anticipation for the international climate agreement that would succeed it.

The Paris Climate Agreement

Paris was a product of decades of action by countries and their diplomats, scientists and citizens, but its direct, truncated historical buildup began with COP17 in 2011 in Durban, South Africa. The conference's product, the "Durban Platform for Enhanced Action," intended to develop another protocol, legal mechanism or large agreed outcome by, at the latest, 2015 (UNFCCC, 2012). This agreement would be rooted in three characteristics of: a) long-term vision and direction for avoiding global warming over 2°C or less, b) equity and differentiation among countries, and c) a binding process to periodically review pledges with transparent monitoring (UNFCCC, 2012). Although ambiguous, the language of the platform seemed to favor binding commitments, contrasting the Copenhagen Agreement's structure. Developing countries used the opportunity to re-assert their position that favored a binding agreement, but one where they remained peripheral to binding commitments; in the event that the agreement was voluntary, the needs of poorer countries would be compromised (Lawrence & Wong, 2017).

The following year marked the advent of the second commitment period for Kyoto, coinciding with COP18 in Doha, Qatar. COP18 was expected to designate the aspirations for the next period for Kyoto and did so; but, with international focus shifted to a new, approaching agreement, faltering enthusiasm resulted in only seven of 37 Annex B countries ratifying their commitments (Dovie & Lwasa, 2017). With its last gasp, Kyoto was laid to rest, and all eyes focused ahead.

The IPCC's Fifth Assessment Report was released in 2014 with the most comprehensive iteration of the climate science report yet. Such was the comprehensiveness that Working Group I's report was based on an astounding 9,200 peer-reviewed studies. Its Synthesis Report was released in November of 2014, in time to pave the way for discussions at COP21 in 2015.

Around the same time, as the last seminal act of the Conference of the Parties before a final agreement was reached, COP20 took place in Lima, Peru. At this conference, the "Lima Call for Climate Action" was implemented, encouraging countries to produce Intended National Determined Contributions (INDCs) before COP21. The INDCs were the expected commitments that countries were willing to make towards the upcoming agreement. The Lima Call for Climate Action urged countries to go above and beyond with their INDC commitments for Paris.

In the formative discussions that led up to COP21 at Paris, deliberations followed in line with partisan historical principles. The EU and Least Developed Countries stood fast by their beliefs that Paris needed to be binding for increased effectiveness. The United States and others, like China, argued for non-legally binding commitments that encouraged a wider scope of commitment among countries. In truth, much of the impetus for the United States' argument was to avoid likely Congressional disapproval and retain agreement constituency in the event of an executive political swing (Clémençon, 2016). This debate would be a precursor to the negotiations at Paris and influential in its final product.

In September of 2015, just three months in advance of COP21, the United Nations General Assembly adopted the *Sustainable Development Goals* (SDGs), a product of two years of negotiation. There were 17 individual objectives ranging from renewable energy adoption to improved education, and each intertwined social, economic and ecological factors. Timely as ever, the SDGs added to the language and objectives of Paris and helped shape the direction of its long-term goals.

<u>Structure</u>

The Paris Agreement was adopted by consensus on December 12, 2015, at COP21. Its overarching goal, directed by the IPCC, was to maintain warming to 2°C above pre-industrial levels with an idealized goal of 1.5°C (UNFCCC, 2016). It was believed the 2°C threshold would prevent dangerous interference with the climate system, but 1.5°C was a new benchmark encouraged by highly vulnerable developing countries and island nations under considerable threat. In the eyes of scientists, 2°C was an ambitious goal, and 1.5°C was unlikely enough that it served merely as a motivator for action (Joeri et al., 2016). To understand the ambition behind 2°C, it is worth noting that, as of COP21, we had expended nearly two thirds of our available carbon budget for meeting that threshold, and the window of opportunity was closing quickly. Beyond temperature control, Paris emphasized all of the UNFCCC's usual, overarching objectives: 1) countries must increase the ability to adapt to climate change impacts, particularly highly vulnerable countries; 2) we must expand low-carbon development; and 3) countries must magnify the flow of finances towards low-carbon and climate-resilient development.

The Paris Agreement rested on the contributions of countries through their INDCs that, for the first time, also produced commitments by developing countries. The INDCs were produced internally based on that country's expectations for what domestic action could be taken against climate change. Obviously, emission reduction commitments and mitigation actions took center stage for all INDCs, but countries also included planned adaptation efforts, financial responsibilities and scientific contribution, among other things. Following the period 2020-2030, the quantified goals of INDCs were set to be reviewed and iteratively changed every five years there on out in what was called a "global stocktake."

The global stocktake measures the progress of each country towards its INDC with the intention of identifying inadequacy of actions. Beyond mitigation, it will monitor adaptation efforts in developing country parties on everything from technology transfer facilitation to project implementation (UNFCCC, 2016) and offer guidance for adjustment to meet commitments. The need for the global stocktake, and its intentions to improve countries' actions, is due to the fact it was decided there would be no punishment for insufficient actions – commitments under Paris would be voluntary. This change marked an official shift in multilateral climate diplomacy in favor of a bottom-up approach. The Copenhagen model was adopted, and the steadfast believers of top-down actions like the EU were overturned. The new lexicon of climate change action changed, as demonstrated through the global stocktake whose temperament was to “request, invite and welcome” improvements in climate action by parties. Now, the impetus to meet INDCs, outside of the desire to limit climate change, was through reputation, peer pressure and the advancement of “soft” power.

Paris’s support for vulnerable countries was demonstrated by its continuation of The Warsaw International Mechanism for Damage and Loss. Originated at COP19 in Warsaw, Poland, the mechanism was designed to improve adaptation and resilience in highly vulnerable countries though adaptation guidance, furthering adaptation practices through technical group collaboration and data analysis (UNFCCC, 2014f). The most highly contentious contribution of the mechanism was its goal to provide monetary compensation to “least developed countries” in the instance of loss and damage from climate change impacts (Sindico, 2016). Although Paris steered clear of controversy and didn’t address the provision for loss/damage compensation, which developing countries had hoped for, the agreement did generate the foundations of a new program for international climate impact insurance as well as a clearinghouse for risk transfer that helped improve risk management strategies (Clémençon, 2016).

The UNFCCC’s historical focus on technology transfer persisted through Paris with the advent of a technology mechanism. The mechanism will accelerate the rate of technology transfer for improved long-term global responses to climate change while promoting economic growth and sustainable development (UNFCCC, 2016).

Technological progress and access can generate considerable mitigation, adaptation and development benefits.

By fortune of timing, the Paris Agreement added the first tangible steps towards sustainable development using the launch point of the SDGs created only months earlier. Although Paris didn't explicitly address the new SDGs, its discussion of overarching sustainable development principles was directly in line with its mission, covering the interconnections between energy, adaptation, forestry, poverty alleviation, health and education (UNFCCC, 2016). Article 2 of the written agreement stated that "[The Agreement] aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty (UNFCCC, 2016)." In this way, meeting emissions goals could be assisted by proper sustainable development measures. This was once a paradoxical statement, the idea that emissions issues could be solved with greater development. Through encouraging language like this, sustainable development grew in its role as a primary feature of the climate change cause. Furthering this is Paris's use of market mechanisms, which are directly tied to limiting emissions and spurring development in tandem.

Article 6/Market Mechanisms

Article 6 of the Paris Agreement focuses on investment and market mechanisms and, although it suggests a large role for these emissions trading mechanisms to play in tackling climate change, the language used is open-ended due to the lack of consensus on design. The hard details of the Article are to be flushed out by the end of 2018. Article 6 covers a number of market mechanisms and finance opportunities, all independent of one another but complementary.

All of the items in Article 6 are exclusive to the Paris Agreement, representative of a "club" for combating climate (Michaelowa, 2017). This is important to the success of Paris because its voluntary nature requires a supply of strong, exclusive incentives for dedicated participation. Two parts of the "club" that offers influential incentives for participation are the market mechanisms of Articles 6.2 and 6.4. These mechanisms offer countries access to cheaper mitigation options that can induce higher emissions reductions than otherwise capable.

Article 6.2 provides opportunities for nations to decrease the costs of implementing domestic, non-market, carbon-pricing, economic policies. This is done through the linkage of domestic policies (i.e. a country can link its cap-and-trade or carbon tax system with another country's cap-and-trade or carbon tax system). By linking with other countries, the carbon market is increased and the cost of mitigation is reduced. The mechanism's potential is far-reaching given that linkage can be effectively established between countries with heterogeneous policy instruments, level of jurisdiction and types of target (Schmalensee & Stavins, 2017). Therefore a hard (mass-based) emissions cap could potentially be linked with a rate-based emission cap (per-unit) or with targets for producing renewable energy (Mehling, Metcalf, & Stavins, 2017). Through the end of 2016, 40 countries and more than 20 cities priced carbon through cap-and-trade or carbon-tax policies, so the opportunity is available. In fact, linkage has already been tested between California and the United States, as well as between Quebec and Ontario in Canada (Mehling et al., 2017).

By decreasing the costs of mitigation, the political resistance to enacting domestic economic mitigation policies is diminished. It is estimated that linkage could reduce the cost of meeting a nation's INDCs by 32% by 2030 and 54% by 2050 (Mehling et al., 2017). Beyond the cost benefits, the act of linking provides an injection of momentum and cooperation into each country's domestic action – acting multilaterally can solve many of "disadvantages" the United States claimed, whose perspective was categorically competitive. Additionally, administrative processes improve as countries learn from one another, optimize control policies and reduce overhead costs (Flannery, 2017). To procure these benefits, though, there must be clear guidelines for transparency and adjustment (Ahonen, Judström, & Upston-Hooper, 2017), as well as economic review and monitoring (Stavins, 2017).

Linkage could enact greater incentives for developing countries to undertake domestic carbon-pricing policies. Reducing mitigation costs is critical to making the transition away from fossil fuels smoother, and countries with carbon taxes like Chile, who will be detailed as a case study later, could benefit from the smooth transition that linkage can provide.

The other primary feature to Article 6 was the Sustainable Development Mechanism (SDM) was an update of the Clean Development Mechanism (CDM), offering to contribute to GHG reduction in host countries and produce mitigation credits for investing countries. The goal of the SDM is to mitigate GHGs while fostering sustainable development through encouragement of both public and private investment.

Details of the SDM are still in formation, expected for finalization in late 2018, but preliminary UNFCCC negotiations have already indicated changes from Kyoto's CDM. Similar to the CDM, countries have full discretion for the scope of their participation and investment preferences. However, this liberty of choice will be further enhanced with the bottom-up nature of Paris. Much like the CDM, but with increased emphasis, private entities are encouraged to participate in the SDM and subsequent carbon credit trading. The SDM could entice large funding opportunities from external sources, and Paris's focus on the private sphere is representative of its confidence in changing market preferences away from fossil fuels (Marcu, 2016). With ubiquitous INDC adoption, beyond Kyoto's limited scope of Annex B countries, the SDM now has no regulated directionality for finance flows – developed countries are now not the only countries that can invest and receive. This is a sign of the changing times, as less developed countries have expressed interest in having access to the other side of investment mechanisms (Marcu, 2016). Nonetheless, although the source of finance is not restrictive, the recipients of investment are intended to be developing countries whose need for sustainable development is priority.

There is plenty of fine-tuning necessary before the SDM's release. The mechanism's overarching points of guidance are to "ensure environmental integrity and transparency," "promote sustainable development," and "apply robust accounting" (UNFCCC, 2016). However, a significant action item for UNFCCC negotiators is correcting the ambiguity around the terms "environmental integrity" and "sustainable development," whose definitions are in many ways prescriptive to individual countries' objectives and circumstances (Marcu, 2017). Also, deciding on the governance and legal structures that oversee the mechanisms is critical to their functioning. Beyond that, improving the additional analysis of investments is important – there were many voices that challenged the integrity of the CDM's emissions reduction accreditation. Tangential to this, the SDM will seek to improve its project impact analysis in accordance with sustainable development, ensuring that projects achieve intended goals for the right reason. This will be detailed later in the Chile case study.

Considering all of this, notwithstanding any unforeseen revelations in SDM design between now and its unveiling, the primary difference between the CDM and SDM is the current market investment trend in favor of low-carbon development. This trend bodes well for the future of the SDM, permitted it has devised correctly the yield long-term uptake and utility. However, when discussing the nature of trends, for both the SDM and linkage mechanisms there are significant future economic and ecological uncertainties that could hinder or accelerate their success and, indirectly, the success of climate action as a whole (Aldy, 2017). Adjustments in equilibrium climate sensitivity, inaccuracies of damage and catastrophe functions, and alterations in adaptation and geo-engineering potentials, to name a few, could all impact the speed, impacts and costs of climate change in the distant future (Stock, 2017). An example of unpredictability was the unanticipated technological phenomena of hydraulic "fracking," which has revitalized natural gas supply, lowered costs and increased the fuel's uptake globally (Flannery, 2017). Recognizing the limits to our foresight, the mechanisms are betting on trajectories favored by our current interdisciplinary knowledge, and if market trends continue as is, the mechanisms could serve as powerful tools for hurdling the economic challenges of climate change action.

Negotiation

Intense debate was needed for determining the final structure of Paris at the end of COP21, and the diplomatic tensions that arose during its negotiation were highly indicative of historical partialities. Deliberation over whether to adopt binding or non-binding commitments was long drawn-out and highly contentious, and the resulting voluntary commitment has mixed reviews. Certain parties argued that non-binding commitments allowed larger freedoms for ratcheting up action over time. Additionally, adopting "soft" measures enabled the agreement to garner ubiquitous international support, which hadn't seemed politically feasible otherwise (Lawrence & Wong, 2017). On the flipside, countries reckoned that hard commitments received greater compliance – there was no denying the compliance of the Montreal Protocol, the World Trade Organization agreements and arms control treaties, for instance (Lawrence & Wong, 2017). Kyoto had received 100% compliance, even if its means and results were questionable. However, in the end, much to the beckons of the Untied States, who sought to diminish its obligatory requirements to enable long-term participation, the motion to favor voluntary commitments by the Copenhagen Agreement was endorsed and non-binding pledges became the backbone of Paris. The remaining top-down elements of this new bottom-up system came in the form of the UNFCCC's monitoring, reporting and verification of Paris's actions (Flannery, 2017).

The decision for voluntary commitments was heavily tied to another ongoing debate over the prospect of mandating that INDCs be produced universally. The debate asked the question of whose shoulders responsibility should aptly be placed. The two sides of the debate were representative of the debate of mandatory commitments, with the EU and a majority of developing countries placing the burden on developed countries, and the United States and other developed or large developing countries seeking universal burden spreading. Ultimately, as a falling domino from the non-binding decision, Paris mandated that INDCs be covered universally, differing from Kyoto's focus on Annex B countries. In light of this, and asserting the UNFCCC's overarching principles, Paris still explicitly maintained that developed countries "should continue taking the lead" on emissions reductions because of their proportionate historical contribution and subsequent benefits received (UNFCCC, 2016). However, with voluntary pledges and limited repercussions, it seemed a natural step to then encourage every country to produce INDCs and idealized emissions trajectories.

The concepts of equity and “burden sharing” that were so instrumental to the success of multilateral climate change action historically were greatly diminished by these outcomes. Just by developing countries adopting plans to limit their emissions, whether they were achieved or not, the burden on developed countries was no lessened. This was compounded by the implementation of voluntary emissions, diminished the impetus for rich countries to act. In response to a shifting burden, Paris reiterated developing countries’ rights to develop, which included “capacity building” for adaptation (UNFCCC, 2016). Sustainable development was now a commonplace focus for all developing countries, and there was hope that its overarching argument for decoupling economic growth and GHGs could guide countries to grow and meet commitments. Paris argued that if all countries mitigated and adapted, the co-benefits of collaborative sustainable development would amplify (UNFCCC, 2016).

Paris offered a number of concessions to developing countries in the wake of these policy shifts that diminished the reality of their needs and vulnerability. Paris motioned to have developed countries support developing countries in creating their INDCs, a process that would require technical analysis, policy understanding and financial support (UNFCCC, 2016). To help inspire meeting these INDCs, beyond market mechanism support, funding for the Green Climate Fund was increased with $100 billion pledged annually by 2020 (Clémençon, 2016). The REDD forestry investment scheme of Kyoto was also updated, refined to have a farther reaching and more positive impact.

The United States had been pivotal to the direction of negotiation, acting as a breaking point on many issues, as it has done with Kyoto, and the result was largely a diplomatic win for the country. The United States had obstructed firm climate action for more than two decades through its geopolitical soft power and reaffirmed its legacy by influencing the bottom-up approach of the agreement. Remember, with its coercion for Kyoto emissions trading, its conception of the APPs voluntary design and the ardent Copenhagen debate, the United States had always encouraged diminished action for the purpose of self-interested growth and deflection of responsibility (Dovie & Lwasa, 2017). Ironically, because countries ultimately conceded to the United States' conditions in moments of failure or success, agreements like Paris occasionally shed positive light on the United States for its ability to resolve multilateral climate disagreement (Clémençon, 2016) – in truth, the thorn in the side of negotiation and provoker of dispute was the United States themselves.

Regardless of the fact that some parties were left unsatisfied, which is largely inevitable with multilateral agreements, the reason for celebration was large. Paris was the first multilateral climate agreement with unanimous pledges for emissions reductions, and the momentum was unprecedented. A wide variety of actors played roles, from government officials to businesses to subnational governments to civil society organizations (Clémençon, 2016). Its glaring fault was the disconnect between its INDCs and the overall objective of Paris. When aggregated, the outcome of 100% compliance with INDCs does not meet the 2°C target, but is rather in the range of 2.7°C- 3.0°C by 2100 (Clémençon, 2016; Lawrence & Wong, 2017). However, Paris was not originally intended to be a "silver bullet" solution for conception but rather a platform to interactively build from, as detailed by its global stocktakes and updated INDCs. This paralleled the focus the Kyoto had undertaken, engaging the reduction of emissions for the long-term with successive agreements needed. Paris is intended to provide structures for limiting emissions and will continue to focus on the language of low-carbon development that will divert global perceptions away from the fossil fuel-based economic growth paradigm that has persisted since the Industrial Revolution.

Ratification

Paris's official release after its construction was very positively received, indicative of its surrounding optimism. The Paris Agreement's procedure for adoption mimicked that of the Kyoto Protocol, needing 55 parties and at least 55% of global emissions to ratify. Opened for signature on April 22, 2016, the agreement took seven months before receiving the needed ratifications and going into effect on November 4, 2016. At its peak, with United States' participation under President Barack Obama, the Paris Agreement signatories captured 97% of global GHG emissions (Mehling et al., 2017). Ironically, the Paris agreement went into effect four days before the United States election; herein lies a twist in the story of Paris's creation, that up to that point, was a narrative of universal optimism and camaraderie.

On June 1, 2017, newly elected United States President Donald Trump announced that the United States would withdrawal from the Paris Climate Agreement. At the time, nearly all 196 parties had signed onto the agreement. However, the Trump Administration had denounced the Paris Climate Agreement since 2016, as part of his "America First" agenda. During his speech in the rose garden of the White House, President Trump declared that the agreement was "unfair" and posed "draconian" financial and economic burdens on the United States (The White House Office of the Press Secretary, 2017). Instead, President Trump argued in his speech he would attempt to renegotiate the commitment to be more favorable to the United States.

The motives behind the Trump Administration's act to remove the United States from a non-binding agreement were primarily based on partisan beliefs. The United States' Republican Party is lobbied heavily by beneficiaries of the fossil fuel industry and indisputably funded by donations from oil and gas companies that influence the administration's subscription to fossil fuels (Zhang, Dai, Lai, & Wang, 2017). The Trump Administration's misunderstanding or negligence to climate change science has led its skepticism and diminished urgency for action. The Trump Adminstration's competitive "America First" campaign has subscribed to the notion that considering historical accumulated impact and "common but differentiated responsibility" was a disadvantage to the United States, a country which has benefitted from fossil fuel use many times over in comparison to developing countries (Zhang et al., 2017). All of this is underlined by the Trump Administration's lack of economic foresight, which has resulted in his favoritism for energy sources that are becoming undesirable and obsolete.

The impact of the United States' withdrawal on the agreement and globe is difficult to exact due to its immeasurable, counterfactual nature, but there are many clear likelihoods. One certainty is that the strong leadership position former US President Barack Obama adopted during negotiations has now been forfeited, sacrificing the success of future climate negotiations and the United States' soft power. Additionally, with INDC non-compliance by the United States, the emissions ceilings for other countries automatically lower and abatement costs will rise, making the target of 2°C far more formidable (Zhang et al., 2017). The United States' withdrawal will also rescind its ancillary offerings of financial aid, which will result in a greater struggle to meet emissions pledges and sustainable development goals for less-wealthy nations; financial aid is a crucial component of the principle of common but differentiated responsibilities. The United States' financial aid has been a critical component to further the UNFCCC's goal of limiting climate change by investing billions of dollar through the Global Environmental Facility, the Green Climate Fund, the IPCCC and various other outlets; much of this finance flow will be halted. With the IPCC, for instance, the United States has contributed 55% of all funding for articles published between 2010 and 2016 Rescinded funding could compromise the ability of the IPCC to further climate science into the future (Zhang et al., 2017).

Interestingly, it is believed the United States' leaving Paris is less damming than what was the case with Kyoto. This is due to the incredible momentum behind an agreement that has inaugurated the first globally universal GHG reduction pledge (Pickering, McGee, Stephens, & Karlsson-Vinkhuyzen, 2017). What's more, although countries may reduce their actions out of competitiveness, the non-binding nature of the agreement means a movement to exit is unlikely. During these times, exiting is even less attractive due to developing countries' awareness of the co-benefits that mitigation and adaptation policies can produce (Pickering et al., 2017)

The United States' withdrawal and resulting déjà vu of Kyoto was met with powerful vocal opposition from world leaders, the global populous and localities within the United States, much like the response that was received during its withdrawal of Kyoto. Internally, in response, individual states like California and New York adopted enhanced emissions reduction policies intended to counteract the United States' expected increase. Outside of the United States, all peripheral nations to the agreement abruptly became signatories, including civil war-torn Syria, whose focus at the time was deservedly internal.

Paris Discussion

The history of uncovering and combatting climate change has been long drawn-out. The United Nations Framework Convention on Climate Change's (UNFCCC) highly bureaucratic process for forging discovery, analysis and subsequent action, all on a consensus basis, is sluggish. Even so, its direction is becoming increasingly refined, and its two primary products, climate change science and multilateral agreements, are now more influential than ever with coalesced initiatives like the Paris Climate Agreement.

Climate change science has had a mixed history, competing with skeptics and limitations for decades, but its solidification has been nonetheless timely. The quest for understanding the impending crisis began with seemingly fringe ideas of serious greenhouse gas effects as far back as the First World Climate Conference and the Nierenberg Report, long before climate change fell on the earth's radar as a global threat. At the time, three decades ago, the assumed connection between fossil fuels and global warming needed fusing; however, the sheer possibility of catastrophe that climate change garnered energy, time and resources towards its understanding. Through the ensuing pipeline of scientific studies, publicity followed and reinforced the cause. Each of the two – science and publicity – reinvigorated the other as a feedback loop for evoking urgency. There is no better example of this fusion than James Hansen's testimony before United States Congress: a sweating scientist in a crowded, swelteringly hot chamber, forewarning Congress of unprecedented disaster. It was moments like these that shook global complacency out of its lethargy. From this point, the collaborative efforts by contributors like the IPCC, WMO, IGBP and the START program furthered the confidence of climate science predictions. Over time, the ambivalent "precautionary principle" that had dominated policy action in the 80s and 90s was phased out, a product of gradually increasing scientific certainty and conviction in the need to act. This has required collaboration, lifetimes of dedication and a strong resistance to vested cynics, but global climate science finally has both clarity and certainty with its diagnosis of crisis.

With recent developments, we've now arrived at a point when our crisis has been defined, its cause has been identified and its solution, at least simplistically, is recognized: reduce fossil fuel emissions. Our awareness of not only the problem but its devastating impacts has improved, and in tandem our sensitivity to the crisis has grown more acute. Science has formed the backbone of our beliefs, but the impetus for urgency has now shifted from proving the impacts to *seeing* the impacts. The faces of the energy crisis are no longer just scientists, but species at risk (polar bears floating atop softening patches of ice) and vulnerable populations (island communities losing their livelihoods due to sea rise) that have induced sympathy and fear. These very tangible impacts on our ecological, social and economic systems demonstrate what scientists foretold and now inspire momentum for action.

As climate change's reality has been solidified, its impacts have simultaneously become both better understood and more intense, doubling the need for effective policy action. Policy has the particularly convoluted task of creating solutions that not only target the straightforward answer of reducing fossil fuel emissions, but also must take into consideration the complexities of regional circumstances, human's competing needs and the expected externalities. As described, finding all-encompassing, appropriate policy has been primary cause of negotiation sluggishness throughout history. To create the most appropriate policy that offers the highest marginal benefit at the lowest marginal economic, social and environmental cost, a range of input across disciplines is necessary. Of the three historical energy crises that humans have encountered, all have caused economic, social and environmental disruption – the proper solution to the current crisis, by default, necessitates consideration for all of these impacts. Incidentally, and not so coincidentally, providing multi-dimensional solutions is a foundational component to sustainable development. The concept of sustainable development has involved interdisciplinary problem-solving since *Our Common Future* in 1987, the UNCED in 1992 and now finding its strongest traction yet through the creation of the *Sustainable Development Goals* established just months before the Paris Agreement.

The pace of policy improvement has been highly reliant on the gradual progress of science; the problem needs defining and the impacts need identification before a subsequent solution can be devised. Nonetheless, international climate change policy's specific development has taken considerable reformation and revision even with a clearer scientific backing. The jump point of the Montreal Protocol, the successes and failures of the Kyoto Protocol, the fallout at Copenhagen and the unique adoption at the Asia-Pacific Partnership all were highly formative progressions for modern climate policy; the collective were all designed with the objective to lower emissions, but each differed in its approach and effectiveness. Multilateral deliberation has been an ongoing feature of climate action since the conception of the UNFCCC, building global directives through long processes of disagreement and consensus. Progress has not been instantaneous; debate regularly splits along usual partisan lines, and resolutions are often dictated by certain countries' tendencies for inflexibility or submissiveness. Ultimately, this climate policy saga, dominated by the themes of deliberation, resolution and revision, has resulted in the formation of a multilateral agreement with the most holistic design to date.

The Paris Agreement's unprecedented impetus for climate change action received global attention by gaining global commitment. The adoption of Nationally Determined Contributions (NDCs) worldwide is demonstration of this with even developing countries consciously committing to limit their emissions below business-as-usual levels, a factor far outreaching that of Kyoto. Standing by its foundational principles in protection of developing countries, the UNFCCC prioritized complementary offerings that encouraged growth in poorer countries. To satiate the competing need for emissions reductions and economic growth, the Paris Agreement enhanced the market mechanisms that originated in Kyoto.

The Kyoto Protocol represented a fundamental change in the way that climate change is combatted by providing the CDM and its incentives to invest internationally in environmentally positive, profitable projects in developing countries. The CDM was revolutionary by offering emissions reductions through a free-market framework. Because of the mandatory requirements, however, the "free-market" characteristics were less than genuine, especially when considering that some countries contributed abnormally high CDM investment at the end of Kyoto's first requirement period in order to accomplish their commitments. Through the process of recognition and revision, the Paris Agreement's Sustainable Development Mechanism has hopes for larger achievement than what the CDM could muster. The SDM is expected to deliver improved project impact analysis compared to its predecessor, especially considering the growing focus on sustainable development. While the majority of CDM project hosting was done by a select number of countries, the SDM intends to equalize impact across countries; the aggregate amount of impact is greatest when spread across a larger population. Because of the Paris Agreement's voluntary nature, market mechanisms are now truly market-oriented, contrasting the forced hand that came with the mandatory Kyoto Protocol, and this will serve as a clear litmus test for true market preferences. Because of the Paris Agreement's arrival coming two decades after Kyoto, the market for investment in low-carbon growth is far more mature, and the SDM should be highly advantageous for both public and private investment interests.

The overarching solution that the Paris Agreement encourages for combatting climate change and solving the energy crisis is central to its references of sustainable development and use of market mechanisms, effectively decoupling emissions and growth. It is this decoupling of emissions and growth that represents a new paradigm development, one that does not sacrifice the vitality and stability of the planet's systems for the sake of economic growth. Although the Paris Agreement has fully adopted this new paradigm for economic development, growth without the increased use of fossil fuels, there still exists resistance to its acceptance as seen with the United States. The lack of urgency demonstrated by the Trump Administration is reflective of its misunderstanding of climate change and the energy crisis; however, it is unclear whether this misunderstanding is about the 1) recognition of the issue, 2) recognition of its effects, or 3) recognition of its solutions. Although the administration has been ambiguous about declaring exactly where the initial disconnect lies between the issue, its effect and its solutions, we can declare with certainty that the Administration does not embrace the solution. Exemplary of this is the Administration's contention that adopting commitments to reduce fossil fuel use yields "economic disadvantages." This view indicates that the Administration has oversubscribed to an antiquated line of thinking and lacks confidence in the greater solution of decoupling emissions from growth. This is no different from its individualistic approach to the Kyoto Protocol, which is omitted itself from out of misguided self-interest. To the contrary, in present day, 195 countries have signed on Paris and agreed that a new paradigm of development has arrived and offers a solution for the future.

There is proof that modern times are beginning to favor economic growth in tandem with emissions limitation. The perceived "economic disadvantages" that come from uprooting an entrenched fossil fuel reliance are now beginning to turn into economic advantages and opportunities. The Paris Climate Agreement has recognized this opportunity and catalyzed its expansion, taking a step beyond problem diagnosis to promote our exit strategy from the energy crisis. It is now the nature of this exit and our future energy system that we turn to.

Case Studies of Crisis and Transition

With the recognition of a fossil fuel-induced crisis, a growing focus on a new paradigm for development, positive market indicators and the Paris Climate Agreement's declaration of commitment to reducing the use of high-carbon energy sources, renewable energy has made a dramatic entrance. The Paris Agreement has clearly signaled that the energy sector's transition to favoring low-carbon sources is now an irreversible trend (SpringerLink, 2017). At the heart of this trend is renewable energy, potentially forming the next energy epoch that has been dubbed the "third solar epoch," (the first was the passive solar energy epoch and second was the agrarian energy epoch), based on solar-fueled renewable energy sources like wind, biomass, hydro and, of course, solar thermal.

The Paris Agreement's guidance towards renewable energy has been strong-willed. The principles of sustainable development undertaken in Paris are alone representative of this. The new development paradigm's energy-specific focus falls beneath the umbrella term of sustainable development, which also encourages the decoupling of emissions from growth, so both have indirectly grown together. As the Paris Agreement commitments slash countries' adoption of fossil fuel energy, there is a void for economic growth to be filled by renewable energy. The global acceptance of NDCs has pushed all countries to take on renewable energy goals, solidifying their stake in the new, clean energy enterprise. As proof, current NDC targets imply that the energy supply in 2030 will have low-carbon resources expanding to replace conventional coal, oil and gas (SpringerLink, 2017). By stimulating public action through the NDCs, private contribution will surely be complementary, doubling down on the dissemination of renewables. To further entice private capital, the Paris Agreement has formed the SDM to improve cost-effectiveness of renewable investment. The SDM lowers the cost of mitigation *and* development through ancillary carbon credit benefits to the investor, offering the opportunity for developing countries to bypass the traditional fossil fuels development phase altogether. The SDM's cost-diminishing effect will only amplify the natural trend towards the affordability of renewable energy. As of 2013, for instance, solar energy had dropped 86% in price since 1996, the year that the Kyoto Protocol and the CDM were enacted, and forecasts indicate a continuing downward trajectory (Agostini, Nasirov, & Silva, 2016). If adoption of renewables under the CDM was considered impressive, then the potential for the SDM is staggering. Already, energy-related emissions have slowed due to renewable energy source adoption (SpringerLink, 2017). With the duality of the SDM and NDC efforts, the emerging partiality of market preferences to low-carbon technology and the underlying trend of increased affordability, renewable energy is being seized on by countries across the spectrums of wealth and emissions production. The ultimate hope, following the principles of sustainable development, is for developing countries to embrace the new development paradigm and be leaders in decoupling their economic progress from greenhouse gas emissions, catalyzing a new era of cleaner, more holistic national growth.

Discussing and analyzing renewable energy from a wide lens is helpful for explanations of macro trends, but digging into the nuances of specific energy and development circumstances can provide important context for understanding the true nature of our propulsion into the next energy epoch. Three specific developing countries separated by thousands of miles with three very distinct economic, political and social circumstances provide an interesting demonstration of what this energy transition may look like and the ancillary benefits it will produce. These countries have a mix of characteristics that have both accelerated and hampered the adoption of the new development paradigm, but the overarching theme to be drawn from their expositions is their new focus on far-reaching goals for an energy backbone that essentially is the "third solar epoch." The enormous influence of the Paris Agreement as the foremost proponent of the new development paradigm in international politics has energized these countries through its principles, policies and desired impacts. These countries' distinct energy transitions are extremely enlightening as to the form national development paths are taking, and their study can help identify the pivotal factors that are critical for renewable energy dissemination.

Morocco

Morocco is nestled in northern Africa, just South of Spain across the Straight of Gibraltar and straddled in the south and west by Algeria. Touching both the Atlantic Ocean and the Mediterranean Sea, Morocco has 1,835 kilometers of coastline, highly valuable to its tourism, fishing and wind resources. Morocco has a

Mediterranean climate, offering four distinct seasons in many of its diverse geographies that include mountains, deserts, coastal floodplains and lowland valley regions. Its natural features offer considerable endowments of solar, wind and hydro resources - three of the resources that form the backbone of renewable energy in the country - while the nation's biomass, geothermal, marine and offshore wind resources are largely unstudied. As an important junction between Africa and Europe with bolstering industry and agriculture, a rapidly expanding tourism sector, population growth and liberalization toward foreign investment, Morocco has experienced formative economic and social development in recent decades, putting pressure on its natural resources. Certain natural resource pressures like water scarcity have impacted the vitality of critical forest ecosystems and agricultural production, damaging the resilience of the nation and damming its ability to grow and thrive in the long-term. Morocco has accepted full recognition of its need to act on its vulnerabilities and combat climate change in the present and future.

Born out of vulnerability, Morocco's proactive stance on combatting climate change through adaptation and mitigation, beginning in the early 2000s, has distinguished itself within the Middle East and North Africa (MENA) region as the nation has undertaken more action within its energy sector than most of its oil-rich neighbors. The year 2015 was exemplary of this, with Morocco's impressive presence and commitment to the Paris Climate Agreement resulting in commitments that will see $37 billion invested in its national energy sector by 2025 (IEA, 2016). The Paris Climate Agreement instilled strong enthusiasm in Moroccan policy agendas, reflected in its ambitious commitments, and Morocco began to turn both its energy sector and climate change, two of its greatest weaknesses, into points of strength.

Relationship with UNFCCC

Morocco has been an active participant of the international climate effort for as long as most countries, beginning its involvement with its signature onto the UNFCCC in 1992 at the Rio Earth Summit. Following ratification of the UNFCCC in 1995, Morocco set up a National Committee on Climate Change in 1996. Morocco was a signatory of the Kyoto protocol in 2002 and organized and hosted COP7 in Marrakech. At COP7, the Marrakech Accords were produced, finalizing the structure and function of the Clean Development Mechanism, a tool that, coincidentally, Morocco used for a multitude of projects. One year after signing onto the Paris Agreement in 2015, Morocco hosted COP22 in Marrakech once again, producing the "Action proclamation for our Climate and Sustainable Development" that reaffirmed the global commitment to enacting change and mobilizing funding for international action on sustainable development goals. Morocco's participation in the UNFCCC has been influential and conducive to the adoption of sustainable development, emissions reduction, adaptation and international cooperation.

Morocco's domestic energy policy has historically been not too dissimilar from its neighbors, dominated by fossil fuels. However, in recent decades, particularly in the last decade, the acceleration of renewable energy policy in

Morocco has been noticeable and worthy. Seeking to cast a new legacy for Moroccan energy policy away from long-time dominant coal, King Mohammed IV instigated a fundamental shift in energy through two avenues (International Trade Administration, 2018): national policy direction and foreign capital access.

The first was the implementation of a new strategy in 2009, called simply the National Energy Strategy, that intended to supply direction for reaching a low-carbon economy in the future with comprehensive plans for renewable energy installation. Primarily through the use of solar and wind energy, the plan hoped to strengthen the security of the supply of energy through diversification, expand energy access to the larger populous at an affordable rate, bolster sustainable development and protect the environment by reducing long-term emissions (International Trade Administration, 2018). The overarching goal was to have 42% of all electricity capacity be delivered from renewables by 2020 and 52% by 2030. One primary component of the scheme was the Moroccan Solar Plan of 2009 (NOOR) which outlined 5 project proposals that would bolster the future capacity of solar energy to 2,000 Megawatts (MW) by 2020. Under the Solar Plan, the Moroccan Agency for Solar Energy (MASEN) was formed, which became the primary national contributor of solar project proposals and maintained oversight of all of the Solar Plan's developments (Simon, Lapierre, & Malek, 2012). The agency operated in a unique position between the government utility (ONEE) and private investors in solar projects. A second primary component to the National Energy Strategy was the National Wind Energy Plan of 2010 which had goals of doubling the total wind capacity to 2,000 MW by 2020, plans for six large-scale wind power sites and extended plans for 2030. With the overarching energy plan, and subsidiary solar and wind plans, Morocco attempted to further its range with the establishment of the Institute for Research and Solar Energy and New Energies (IRESEN) in 2011, a science group intended to further the research of renewables specific to a Moroccan context. The first two products of the Wind and Solar Plans, the 150 MW Taza Wind Farm and the 160 MW "NOOR I" Solar Power Plant, came in 2015 and signaled the first successes of grandiose national policy directives that Morocco undertook.

The second piece to King Mohammad IV's support of renewable energy was the attraction of foreign investment. In 2010, a legislative decision permitted the passing of Law 13-09 which authorized private construction, production and sale of renewable energy for any natural or legal person. The law meant that renewable energy could now fall within a private market outside the national utility system, ONEE, that has previously monopolized energy production. The opportunity for private ownership that hadn't previously existed transformed Morocco as a flow of foreign investment entered Morocco's border, injecting capital into the young renewable energy industry.

Current Energy Situation

Morocco's energy mix, as of 2015, was heavily dominated by fossil fuels (66%), most of which came from coal power (31%). Despite this, Morocco's energy system is still one of the most diverse in the region (APICORP, 2017). Beyond coal, its energy mix includes 20% oil, 15% gas, 22% hydro, 10% wind and 2% solar. Morocco's historical energy system, which operated around fossil fuels, was similar to its regional neighbors except that Morocco used proportionately much higher coal energy for its production. In fact, Morocco was one of the first MENA countries to begin using coal on a large scale, demonstrating the country's likening to the traditional growth paradigm. Coal power plants served as the backbone of the country's generation system, accounting for 45% of electricity production (Kousksou et al., 2015). Taking on coal was a strategy of diversification for Morocco, necessary because Morocco lacks domestically produced fossil fuels. Amazingly, Morocco imports 96% of its resources for energy, coming from its close neighbors of Spain and Algeria (Kousksou et al., 2015). This is a dramatic drag on the nation's sovereignty, as the entire national grid is at the whim of fluctuating global fuel prices and geopolitical happenings. Fuel prices can shift dramatically day by day, putting Morocco in a highly vulnerable position and burdening the national budget. In 2014 alone, the import of fossil fuel cost Morocco an astounding $10 billion USD (IEA, 2016), one-ninth of the $101 billion GDP (before export cost). Regardless of the burden this placed on Morocco's budget and sovereignty, Morocco's attitude was so centric to growth in recent decades that it accepted its importation fate and adopted a strategy around fossil fuels, costing the country billions in recent decades, especially lately. Because of this incredibly burdensome import rate, one of the biggest economic challenges for Morocco is garnering a secure and stable supply of energy that offers cost reductions (Kousksou et al., 2015). Plugging an annual drain of $10 billion could allow reallocation to important national sectors like health, education and welfare – sectors that spur development and perpetuate growth.

Morocco's appetite for energy is persistent, with 5% annual growth in energy demand since 2010 and no expectations for that rate of growth to narrow any time soon (IEA, 2016). This puts Morocco in tough circumstances, who now must doubly focus on energy production to correct a trade imbalance that is only expected to rise. Matching this energy demand is national production, which rose on average 3.1% per year from 2004 to 2014 before dropping slightly since. This growth is both the cause and answer to the growing energy demand and must remain consistent for Morocco to achieve its development goals. Unfortunately, some industries like agriculture, which accounts for 15% of GDP and 40% of the workforce, and tourism, one of Morocco's highest growth industries, are heavily reliant on weather and climate. The impacts of climate change, like sea rise, coastal erosion, heat waves and drought, could leave Morocco perpetually exposed economically, damaging Morocco's ability to invest in the very sectors that could foster national development like energy, education and industry. Understanding this, Morocco is fighting two uphill battles with its economy, one in the form of import dependence and the other in the form of climate change. Favoring a strategy that attempts to target both could be a solution to Morocco's woes.

Although Morocco is dictated by a kingdom and the "makhzen" ruling elite, Morocco's economic policy is considered relatively liberal and largely governed by the laws of supply and demand (Kousksou et al., 2015). Particularly in the last decade, Morocco has swung in favor of free market principles and foreign investment acceptance. Until recently, free market profit seeking would have favored coal and oil, with their competitive pricing, but as the cost of installation and operation of solar and wind have plummeted, savvy investors are seeking new opportunities in the technologies. These opportunities have been facilitated by Moroccan economic policy, which has created a unique role for the Moroccan government within the energy sector that is no longer domineering but is not entirely laissez-faire either. No examples are as representative as law 13-09 and the complementary buy-own-operate-transfer (BOOT) system.

Law 13-09's passage brought fundamental changes to the Moroccan energy system. By allowing any individual to invest, the playing field was opened and investors were encouraged to compete, all underneath the national government's oversight, of course. The private capital that was received was invested into a public-private funding structure, the BOOT structure. The way the BOOT structure works is that a private company, either foreign or domestic, dubbed an "Independent Power Producer" (IPP) bids in a reverse auction on a project for investment in renewable energy in Morocco, with the "bid" equated to its offering price for energy and the lowest price winning. Upon winning the auction, the IPP constructs, owns and operates the facility, selling its energy at a contractual, guaranteed price to ONEE. After the contract is up, usually after 20 or 30 years, the facility is transferred to the government for public production and sale (Gatti, 2012). Although the IPP actually owns the plant during the contract, the government remains involved through the

MASEN, which sits at a midway point between the IPP and ONEE, by advising the project and maintaining a minority equity holding in the project. At a major solar project in Ouarzazate, for example, the government maintained 25% equity in the project to retain influence before assuming full ownership after the 20 contract expired. The investment becomes attractive for financiers because Morocco provides debt financing and remuneration on losses to the IPP. The debt financing is provided during the time of construction to assist the project with staying on schedule. The remuneration is offered based on the project's bidding price; if the IPP doesn't receive revenue equal to its bidding price (due to low demand or lower spot prices), the MASEN will provide remuneration equal to the loss (IEA, 2016). Leveraging this government funding allows IPPs to shift away their risk and bid very low, guaranteed prices for production. If no remuneration is actually needed, Morocco wins by receiving low energy prices and a new renewable plant at the end of the contract's life (IEA, 2016).

The BOOT strategy's benefits are long-winded. The scheme encourages more private investment by guaranteeing a revenue for all prospective buyers who then must only ask questions of their ability to lower their own costs. The scheme helps inject new foreign capital into Morocco given the opportunity for low-risk international investment in an emerging market. Technology and know-how is transferred, meeting a priority of the UNFCCC and Paris Agreement that benefits Morocco in the long term. Projects are also completed in timely fashion and on planned budgets, due to the cooperation between private and public spheres. Lastly, the burden of public infrastructure development is released and passed onto IPPs. In large part because of this clever strategy, Morocco has been graced with a generous influx of foreign investment, securing funding for a number of projects often at very low rates (IEA, 2016). Additionally, with recent updates to law 13-09 allowing net metering policy for solar photovoltaic (PV) and onshore wind, electricity producers can sell up to 20% of their generation back to the national grid at fair prices (Hochberg, 2016). This will surely be a critical step in bolstering an already blossoming private investment in renewable energy for Morocco, whether through industrial or residential means.

Nationally Determined Contribution

Morocco is recognized as having an extremely productive area for wind and solar energy. Morocco's fortunate intersection with the trade winds provide highly beneficial resources for wind power, with some wind farms enjoying a load factor of up to 45%, one of the best factors in the world when it comes to onshore wind (Yaneva, 2017). For solar power, Morocco has extraordinarily favorable conditions almost country-wide, with some areas receiving up to 30,000 hours of sunlight per year (Karakosta, Marinakis, & Psarras, 2013). Fortunately, with such potential, Morocco is also motivated under the Paris Climate Agreement. As mentioned, Morocco has been dutiful in its participation and influence within the UNFCCC, acting as a leader within North Africa and the MENA region. Morocco was a strong public proponent of the Paris Agreement and offered motivation to other countries in spite of the United States' withdrawal (Doyle, 2016). Morocco was also one of only nine countries that offered a Nationally Determined Contribution (NDC), post-COP21, with more aggressive commitments than they pledged their Intended Nationally Determined Contributions before COP21.

Morocco's overarching goal, as a developing country, is to make its territory more resilient to climate change while ensuring a rapid transition to a low-carbon economy. Both of these objectives are eerily close to being solutions for the two economic issues cited before - damages from climate change and fossil fuel import debts - meaning that many of Morocco's Paris solutions coincidentally (or not so coincidentally) match their economic interests. Morocco's specific goals on emissions are extremely ambitious with a pledge to reduce emissions below business-as-usual by a whopping 42% by 2030 (Morocco, 2016), more than any of its peers in the MENA region. This 42% emissions reduction considers changes in Agriculture, Forestry and Other Land Use (AFOLU) practices (i.e. updated version of LAFALO from Kyoto); without considering AFOLU, the reductions will only amount to 34%. If international funding was not available as expected, the overarching emissions reduction goal subsides to 17% by 2030 - considerably less than the original goal - and to only 13% without AFOLU. Total funding required to reach 42% would be $50 billion, with $26 billion from foreign partners and $24 billion provided internally (Morocco, 2016). This is a large sum of money when considering the Moroccan GDP of $101 billion (2015).

Morocco's spread interest in adaptation and mitigation has often been split fairly evenly, with a slight favoring of adaptation (64% of adaptation/mitigation spending) out of necessity, given the developing country's vulnerability. The NDC's planned investment in resilience will also deliver economic benefits like protection of areas for fishing, aquaculture and forestry, while preserving ecosystems and agricultural resources for productive uses.

Mitigation efforts in the NDC are mainly spread around the central theme of building a low-carbon development strategy. This concentrates the focus in areas like energy, transportation and housing/infrastructure. Morocco's development is "driven by great political will" with intentions of lowering reliance on imports and increasing its share of renewables (Morocco, 2016).

For renewables specifically, Morocco hopes to reach 52% of installed capacity from renewable energy by 2030, with 20% from solar, 20% from wind and 12% from hydro (Morocco, 2016). By sector, electricity production would be expected to produce 45% of the total emissions reductions by 2030, with the rest roughly evenly distributed among industry, residential, transportation, waste, agriculture and forestry.

As extensions of the renewable goals, the country also hopes to use renewables for operation of large-scale public transit systems in urban centers, shifting the fossil fuel burden away from the transportation sector (Morocco, 2016). The country also claims that it intends to decrease fossil fuel subsidies over time, an act it has been already undergoing in doses in recent years.

The Paris Climate Agreement's understanding of foreign investment interest in emerging markets eager for renewable energy led it to a continuation of its Clean Development Mechanism (CDM) through a new tool, the Sustainable Development Mechanism (SDM). Paris has high hopes for the SDM to have greater success than the CDM which was useful in its time but saw a large majority of its investments concentrated in only a few burgeoning nations. Over a decade after the CDM became effective, the investment outlooks for many countries are much more attractive with the expansion in availability of pertinent investment information and the globe's increasing national appetites for foreign capital. Morocco has not diverged from either of these trends, as proved by my descriptions above, and now has the appropriate legal infrastructure and government support for larger participation in the SDM after recognizing the benefits of the CDM.

Morocco's participation in the CDM placed the country somewhere in the upper half of users relative to the other MENA countries. The projects undertaken through the CDM in Morocco have been studied to understand the benefits beyond technology transfer and financing of projects (Kousksou et al., 2015) and to better flush out Morocco's focus for the SDM and investment beyond. Of all the registered projects, as of 2012, within the 11 project types that cover everything from education to air quality to health, the top four categories of investment that were the biggest catalysts of sustainable development were growth (economic development); employment (new job creation); balance of payments (reduction in imported fossil fuels); and energy (Karakosta & Psarras, 2013). Renewable energy would seem a common denominator among all four of these categories, providing energy that's necessary for growth, job creation through project installation and operation and energy independence. Not surprisingly, then, as recognized by Morocco, wind power was the most popular type of project across the whole country. Furthermore, when studied on a benefit per project basis, solar PV has the highest number of overall benefits per investment, closely followed the grouping of wind, biomass and landfill gas recovery projects (Karakosta & Psarras, 2013). With this clarity around the elevated benefit/project ratio that comes with renewable energy technologies, it is clear that investments through Paris's SDM will be important for achieving a duality of emissions reduction and sustainable development, particularly if those investments are focused around renewable energy. Morocco's NDC has stressed its intent to participate in the market mechanisms, and has already set a number of national plans in the works to facilitate doing so.

Renewable Energy Trajectory

With the National Energy Strategy of 2010 mentioned before, King Mohammed IV focused on diversification, increasing supply and lowering the price of energy while simultaneously improving the nation's energy efficiency (IEA, 2016). With the use of the CDM, his goals around Wind and Solar were largely met and now continue to expand toward the future, building off of the commitments made to, and momentum from, the Paris Agreement.

The National Wind Plan met the objective of its first phase, reaching 850 MW of installed capacity in 2016. This amount, amazingly, only accounted for one-thirteenth of the nation's wind potential, representing the initiation of a long future for wind energy (Hochberg, 2016). Abdelkslek Torrès, a 50.4 MW project that was one of Morocco's first projects (Kousksou et al., 2015), was part of Morocco's initial investment in wind instigated by the CDM. Other major projects facilitated by the CDM were Essaouira (60 MW), Tangier (140 MW), Akfenir (200 MW), and Kalladi (120 MW), contributing a large portion to its 850 MW first phase.

Looking forward, the National Wind Plan has six other major projects outlined for its next phase with a planned investment of $3.7 billion and the goal of increasing wind capacity to 14% of the country's total energy balance by 2020 (Kousksou et al., 2015). If these projects succeed, which is likely given the effectiveness of the BOOT strategy, Morocco could exceed its goal of 2,000 MW of wind energy by 2020 (IEA, 2016). Already, by the end of 2017, Morocco broke the 1,000 MW threshold for wind energy with the addition of numerous projects going online. Morocco has also stepped up its domestic focus with the announcement of a wind turbine factory in Tangier, owned by Siemens, that plans to bring 700 jobs (Hochberg, 2016) and complement the Moroccan owned wind tower factory. Although Siemens is an international company, internal production of wind towers and turbines will further reduce the inundation of resource imports into the nation in a step towards self-sufficiency.

The Moroccan Solar Plan of 2010 was slow to start, but is now well underway with a total national solar production of 206 MW installed at the end of 2017, a number that was just 40 MW in 2014. Up to this point, the mix is currently 80% concentrated solar power (CSP) and 20% PV, due to the fact that this was easier with larger scale projects at the initial solar planning phase. As the cost of PV continues to plummet, more PV is expected to be taken on in the near future. The Solar Plan contains seven expected projects to be implemented by the MASEN under the BOOT scheme. There are other projects planned by sole private developers and ONEE as well – the national utility, ONEE, plans for at least 500 MW developed by 2020. The national utility's complementary work to the MASEN's public-private contribution aptly demonstrates the nation's philosophy of balancing private and public control.

Name	Year Complete	Technology	Capacity (MW)	Price/kWh ($)
NOOR I	2015	CSP	160	0.18
NOOR II	2018	CSP	200	0.15
NOOR III	2018	CSP	150	0.16
NOOR IV	2018	PV	70	0.058

Looking at the table above, of the NOOR I-IV plants in Ouarzazate, a sun-rich area in southern Morocco, it is clear the winning bids for kilowatt hour (kWh) production (price/kWh) by IPPs have gotten lower over time relative to capacity, showing an increasing efficiency and competitiveness with each new project. Morocco's first major CSP solar project, "NOOR I" on the first row of the chart was completed in 2015 as a registered CDM project, succeeding as the first large-scale, high-risk solar investment for the country (MASEN, 2012). At $0.18/kWh, the pricing bids received for the project were 25% lower than the Moroccan government expected (IEA, 2016), signaling that the CDM achieved exactly what it intended to do, lowering the cost of mitigation across international lines.

NOOR II and III but had improvements to the original NOOR I design, adding technological features and lowering the cost even further. For both, a seven hour storage capacity was added that doesn't exist for NOOR I or IV and allows the plants to be concentrated in their contribution during daily peak demand when energy is more valuable and needed (Hochberg, 2016). These technologies are necessary to overcoming the infamous intermittency barrier to renewable energy. Meanwhile, even with the addition of storage capacity, because NOOR II and III are two of the largest CSP projects in existence, they contain some of the lowest worldwide tariff prices for CSP at $0.15/kWh and $0.16/kWh, respectively (MASEN, 2015).

NOOR IV is a project of its own achievement, planning to quadruple the nation's PV resources. Although NOOR IV is comparatively limited in its scale with 70 MW, it has been awarded an astounding price of $0.058, one of the lowest ever seen for solar power (International Trade Administration, 2018). This price is a testament to the effectiveness of Morocco's BOOT scheme which is feeding off of the current momentum around international renewable investment.

It is worth mentioning that Morocco's current philosophy on fossil fuels, as reflected in their NDC and national energy plans, is one that asserts the principle of common but differentiated responsibilities. At this point during Morocco's rapidly rising energy demand, while renewable prices are plummeting and commercial batteries for renewable are on the cusp of affordability, natural gas will be important for the country to subsist and endure. Although this does not mimic the "green economy" trajectories environmentalists hope for, it is worth acknowledging the reality of Morocco's development and the reality of its impact. Natural gas production growth has been astounding recently, and affordable prices for a fossil fuel have given life to consumers of it, offering Morocco a cheap, short-term import strategy to meet its national demands. For coal which has formed the backbone of the country's energy supply, it is expected to remain that way before its share is expected to decline beginning in 2020 (IEA, 2016). It is important to put both of these facts into context. Natural gas, for one, has emissions half as damaging as that of coal (Heath, 2015). For natural gas, there is expected to be four GW added by 2030. What seems like an enormous figure, in reality, is *less* than Morocco expects to add in renewables in that time. This must be indicative of either, 1) the country is so ethically inclined that it sacrifices sound financial decision making for clean energy, or 2) there is an economic case to be made for a transformation of the energy system. Morocco has no obligations to reduce its emissions by large rates nor is it required to limit the use of cheap natural gas or coal; Morocco's participation in the Paris Agreement is completely voluntary. Morocco is a developing country with many public health and welfare issues that need tackling, dissuading the nation from making irresponsible fiscal decisions. Therefore, for a country whose GDP per capita is 5% that of countries like the United States, a country that cites economic damages from environmental proactivity, there must be financial practicality and development benefits that can be derived from these investments.

Obstacles

There are barriers to Morocco's transformation that will require proactive policy-making if the trajectory of renewables is to continue. The grid's capacity does not match what is desired, highlighting system integration failures that could limit the scope of renewables expansion (IEA, 2016; Kousksou et al., 2015). This is especially true in rural areas, which is part of the reason rural electrification programs have not received a strong backing (International Trade Administration, 2018) and combines with a lack of incentives for small-scale, residential units (IEA, 2016). Beyond wind and solar, more research is also needed around biomass, geothermal, marine and offshore wind energy (IEA, 2016) to offer Morocco a truly diverse energy system.

Conclusion

Morocco is very unique in its energy situation. Fossil fuel imports pose a burden on its economy, draining national funds and diminishing its ability to invest in a positive-growth society. Simultaneously, Morocco is forced to put funds towards investment in resilience and adaptation due to climatic impacts that can damage livelihoods and have extended economic impacts. These costly adaptation measures are necessary, of course, due to the very same bane that troubles Morocco's economy, fossil fuels. It is in this way that Morocco is motivated on two ends: partially from economics, and partially from crisis. Breaking the chain of losses is possible with the proper energy transformation that tackles Morocco's import liabilities and mitigates climate change.

As exemplified in Morocco, the prices of wind and solar have begun to subside from their normally lofty costs to having highly affordable marginal production and consumption costs. Morocco's suitable solar and wind endowments are helpful in this cause, but the financial system that Morocco has created is mostly responsible. Morocco's renewable landscape is indicative of a highly attractive one, opening its doors to foreign investment with a BOOT strategy that offers private investors risk-sharing, remuneration in case of loss and a clear exit strategy. Impressively, with well-planned projects, partnership with IPPs and the establishment of a competitive market, the government could see very minimal costs to itself due to the low prices. Morocco's establishment of a competitive market for renewable energy in its country is not to say that free market, capitalist agendas are best for renewable energy. Rather, it is these free market situations that add clarity to where market interest lies, and in this particular case, with competitive bidding that has successfully funded projects and has produced some of the lowest renewable *or* non-renewable energy prices in the world, it is clear there is enormous interest in investing in the transformation of countries like Morocco.

The impact of international climate agreements has been underway in Morocco for some time. Morocco's use of the CDM for building cost-effective projects targeting sustainable development, and its NDC's testified commitment to the SDM, both demonstrate its interests in building off the market mechanisms and opportunity that Kyoto and Paris have created. As with all developing countries, Morocco has asserted its belief in common but differentiated responsibilities, electing to continue its use of natural gas and coal in the near-term before phasing those resources out. However, at a time when natural gas is appealingly cheap, it is remarkable that the nation is voluntarily outpacing natural gas' growth with renewables.

Morocco is beginning to decouple its fossil fuel use from its GDP growth and could effectively "leapfrog" the energy intensive phases of development that many developed countries deemed necessary historically. There are many questions that will be asked of Morocco’s NDC, from the effectiveness of Paris’s “voluntary” measures, the conditional funding expected and the lesser responsibility that Morocco assumes as a non-Annex I country. Although trend lines of Morocco energy-intensity and GDP have moved together historically, as of 2012, the two have diverged and GDP has outpaced energy intensity on an indexed basis (IEA, 2016). This is evidence of Paris’s momentum and evidence that we are entering a new age of growth, one that previously didn’t allow “leapfrogging” of this kind. As Morocco’s foreign minister said on the eve of COP22 in Marrakech, even if the US is to pull out of the Paris Agreement, “there is no turning back… We can only advance” (Doyle, 2016). Looking at Morocco’s initiative, it certainly seems that way.

Chile

Chile is located along the western coast of South America, stretching from Peru all the way to the Southernmost point of the continent and sharing 2,700 miles of coastline with the Atlantic Ocean. On the east and northeast, Chile is bordered by Argentina and Bolivia, two long term trade partners, in addition to Peru. Chile is mostly mountainous in geography, covered by the spectacular Andes range, but also contains arid deserts in the north, highly arable agricultural land centrally, and an inhospitable, cold climate in the south. The variety of climates and geographies has created a diverse resource mix for Chile with unique economic positions.

Chile has very favorable political and economic climates for attracting and retaining foreign investment. Characterized by political stability, government effectiveness, access to capital, regulatory quality, rule of law and control of corruption, Chile's strong governmental fabric for growth has deemed the country open for business (Watts et al., 2015). Economically, Chile has been fortunate with an endowment of valuable minerals, containing the world's largest copper reserve along with extensive reserves of molybdenum and lithium (Rivas & Cardemil, 2015). The extraction of these minerals has yielded dramatic economic growth in recent decades, so much so that Chile has achieved the highest GDP per capita in South America and was admitted to the OECD in 2009. The economy has been largely built around mining, which makes up 57% of total exports and leaves the country highly exposed to commodity price fluctuations (Chile, 2015). Simultaneously, the burgeoning mining industry has been an intense consumer of energy, accounting for around 38% of the nation's total energy demand; it is expected to expand its energy needs by 5% annually, accounting for 60% of the national growth in energy demand (Agostini et al., 2016). Despite the mineral endowment, fossil fuel reserves are limited in the country, resulting in an import of 69% of its energy in primary form (Eurostat, 2015) - not nearly the burden faced by Morocco but still consequential, raising Chile's energy price above most other South American countries (Agostini et al., 2016). The dependency on imported fuel, all of which is fossil fuel, is a point of vulnerability for Chile, and the need for diversification and energy security is visible.

Beyond economic vulnerability, Chile faces a number of serious environmental threats from climate change. Of the UNFCCC's nine characteristics of vulnerability, ranging across industries and impact levels, Chile captures seven. Chile is especially threatened in the areas of fishing, aquaculture, forestry, livestock and farming, water resources and biodiversity, caused by overarching shifts in temperature, rainfall levels and snow pack as addressed in the National Climate Change Action Plan (Chile, 2017). By sustaining climatic damages in addition to industry impact costs, Chile could incur annual losses of up to 1.1% of the country's GDP by 2100 (Cansino, Sánchez-Braza, & Rodríguez-Arévalo, 2018).

Chile has a unique combination of good characteristics for investment (political stability, openness to foreign capital, etc) and bad characteristics of vulnerability (energy insecurity and climate damage) that together have bred exceptional action towards renewable energy adoption. The country has taken on impressive commitments with the Paris Climate Agreement and, through its dedication to building a clean energy system, proven those commitments surmountable, serving as a strong example of what renewable energy overhaul could look like.

Relationship with UNFCCC

Chile's participation in the UNFCCC has been constant and enthusiastic, tempting it to be a leader for its region on climate change action. Chile was a signatory of the UNFCCC in 1992 and a signatory of Kyoto in 1998, helping to instigate what was, at that time, the foremost single act toward global emissions reductions. In the buildup to Paris, Chile helped create the wind behind the sails of negotiation. Chile was just the 4th country to submit its First Biennial Update Report to COP20 in 2014, a report that provided updates on a country's climate progress to improve multilateral discussion and direction for the Paris Agreement (UNFCCC, 2014b). Following this in 2016, in the midst of Paris's configuration period, Chile was also one of the first nations to submit its extensive Second Biennial Report, a report intended for adding transparency to non-Annex I countries' actions and a better understanding about what support would be necessary. Chile's prompt participation received congratulatory recognition for its contribution to forming Paris's more nuanced details (MMA, 2016). Chile's active participation has not been without benefit, taking full advantage of international non-market mechanisms like the Global Environmental Fund, a predecessor to the Green Climate Fund which caught traction at Paris, offering investment capital for sustainable development in non-Annex I countries (MMA, 2016). The projects have covered a variety of needs, like electricity access, by providing funding for solar energy projects in rural areas that lack grid access (Badenier, 2016). Chile's historical participation in the UNFCCC and support of negotiations, particularly with Paris, has been exemplary for a non-Annex I country.

Current Energy Situation

Chile's energy policies have evolved over time, largely due to economic shocks and crises, to arrive at a present-day strategy that idealizes liberalization, foreign investment and renewable expansion. Renewables have been a piece of Chile's energy infrastructure for decades; large-scale hydropower has been a fundamental energy source since the 1960s. Hydropower supplied 65% of total electricity in the 1960s and 80% in the 1980s before proportionally shrinking in the 90s as the energy supply expanded (Chile Ministry of Energy, 2016). Chile had 4,430 MW of hydropower electricity in 2000, which is equal to the country's wind and solar growth objectives today. In the 18 years since then, its hydro has expanded on average 3% annually (IRENA, 2017). Much of hydro's slowdown is due to Chile's shift in focus to diversification, after irregular drought caused unexpected shocks in hydropower output. This is largely why Chile now focuses on the expansion of "non-conventional renewable energy" that doesn't include large-scale hydro, a category the country has already developed.

The nation's energy phase following big hydro was the influx of natural gas electricity production. Chile began its import of natural gas from Argentina in the late 1990s, investing heavily in pipeline infrastructure and building a suitable gas distribution network. However, over time, Argentina's supply constricted and the country began to ration its export with focus on domestic use (Agostini et al., 2016). With natural gas imports all but stopped, Chile continued on its quest to diversify and secure a long-term energy supply. The search for internally supplied energy sources ensued, and soon after, wind and solar made their entrances in the early 2000s. Their introduction led to the gradual adoption of an energy strategy that favored renewable energy, iteratively increasing their focus through quotas, incentives and openness to renewable investment.

Chilean legislation worked in tandem with national strategies. In 2008, Law 20,257 was passed, establishing a quota for companies' use of renewable energy that enforced a monetary punishment for under-adoption. By 2013, the first large scale PV installation was completed, and although minimal, it was helpful in combatting the unreliable energy supply which was recently exacerbated by periods of drought and lack of natural gas access (Cansino et al., 2018). Simultaneously in 2013, Law 20,257 was updated with a target for renewable energy to occupy a 20% market share of electricity generation by 2025. Thus far, this has been met convincingly, and in some years, companies have doubled the required renewable quota (Norton Rose Fulbright, 2017). In another very serious move by the government that asserts its long-term intentions, Chile implemented a tax reform in 2014 imposed on GHG's and harmful emissions in a three pronged focus (Chile, 2015). Taxes are imposed on 1) energy producers over 50 MW of capacity at $5 per ton of CO_2 emitted, 2) non-fuel efficient vehicles, which has already greatly reduced the number of inefficient vehicles (Chile, 2015), and 3) fixed sources of SOx, NOx, and particulate matter. Although this is expected to have a very positive effect on domestically produced emissions, there is worry of offshoring by the most contaminating industries, which could impact Chile's economy (Cansino et al., 2018). To combat this, Chile's attention has turned to the

Paris mechanism for linkage, which offers to combine national carbon pricing policies with cheaper implementation and has smaller localized impacts on economies but generates greater rippling effects globally (Aldy, 2017). Following this series of legislation and action, Chile then set its national direction with its "Energy 2050" plan in 2015, a plan that established the pillars of a more sustainable energy market that imagines energy at the center of the country's development strategy (Chile Ministry of Energy, 2016). This national strategy was pivotal in guiding Chile's Paris commitments, matching Paris's goals and steps to accomplish those goals.

Chile's political and economic stability have made it one of the fastest growing economies in Latin America over the past two decades with average GDP per capita growth of 8% annually since 2000. As is typical of most developing countries, energy demand mimics this growth, but the scale of this growth is not typical. Energy demand has grown 178% from 1990-2013, well above average (56%) and for OECD-American countries (104%). Chile's two national grid systems, the Central Interconnected System (CIS) and Northern Interconnected System (SING), are expected to grow in demand 73% and 94%, respectively, from 2015-2030 (Cansino et al., 2018). Economic growth has also spurred emissions growth; between 2007 and 2013, data has demonstrated very strong coupling between growth and emissions, particularly for Chile's energy industry (Cansino et al., 2018).

Chile has long been one of the most attractive emerging markets poised for investment in Latin America, well known for its openness to trade, investment, technology transfer and cultural integration. According to Bloomberg Energy Finance

Climatescope 2016, Chile was second in the world in renewable energy investment attractiveness (ClimateScope, 2016) and the top performer for Latin America in the World Bank's Ease of Doing Business Report in 2017 (World Bank, 2017). Chile has exceptional legal framework for inviting foreign companies, having extremely open markets and limiting its current controls (Norton Rose Fulbright, 2017). Its openness to foreign investment is visible and intentional and dwarfs the acceptance rate of close neighbors like Bolivia. These characteristics have primed Chile for the injection of foreign capital into the country towards renewable energy investment. Complementing this is Chile's direct subsidization of renewable energy growth, offering concessions of diminished land costs for private developers building on state land. This has been fully taken advantage of, as nearly 40% of all Chilean solar and wind projects are located on state land (Norton Rose Fulbright, 2017). State imposed concessions have been critical in giving a subtle push to renewable developers, diminishing the risk of investment enough to encourage large scale adoption (Rivas & Cardemil, 2015). Chile's reason for such openness to, and encouragement of, renewable energy is built around its desire to achieve dual objectives of economic growth and emissions reduction, resulting in decreasing "carbon intensity," the measure of emissions production per unit of GDP (Cansino et al., 2018). No example of Chile's openness to investment is as indicative as its national energy system.

The onset of ambitious strategies for liberalization came in 1980, when Chile was one of the first countries in the world to completely privatize their energy system which up to that point was state owned and operated. This greatly altered the transmission and distribution systems and allowed greater market control of the Chilean energy system. Companies were forced to shift their strategies to combat stiff competition, and those producers with the cheapest energy sources won price bids, which at the time were largely hydro, coal and natural gas producers (del Sol, 2002). Over time, the system evolved and now seems to be leaning towards non-conventional renewables. In 2015, a law was passed making the price bidding process more competitive with longer contracts and specific timing iterations (day, peak, night). As a result, in the 26 auctions held that year, more than half of the bids were awarded to renewable developers (Norton Rose Fulbright, 2017). Entering into 2015, Chile's average cost for electricity was among the highest in OECD countries, but now prices have tumbled, and renewables have been central that.

Nationally Determined Contribution

Chile's goals, as outlined in its NDC, are built around three key areas: resilience to climate change (adaptation and capacity-building); control of greenhouse gas emissions (comprising the mitigation pillar); and cross-support for climate action (technology transfer finance). Its goals are very ambitious, planning to reduce carbon intensity (CO_2 emissions per GDP unit) 30% below 2007 levels by 2030, contingent on economic growth that matches the previous decade's growth (Chile, 2015). With funding, the conditional reduction of carbon intensity by 2030 would be 35-45%. Neither of these figures capture the effects of AFOLU activities, which Chile intentionally separated for the purpose of clear goal setting. Chile's commitment to AFOLU impact mitigation is based on two large recovery efforts that preserve a total of 200,000 hectares of forested land, which would account for 1,500,000 tons of CO_2 as of 2030. Combining with these objectives, the National Energy Agenda of Energy 2050 has highly ambitious targets for renewable adoption, included in the NDC. Its goals are to reduce marginal costs of electricity by 30% below 2015 levels by the end of 2018 with 20% of the energy mix coming from renewables by 2025 (Chile, 2015). It is hoped that both goals can simultaneously be met through the propagation of renewables.

Chile's NDC goals are multidimensional and interdisciplinary. Its goals specifically addressed the issues of education, health and inequality, and saw the creation of a low-carbon growth strategy as an answer for increasing welfare opportunities without perpetuating the increase in emissions (Chile, 2015). Chile also stressed the need to participate in further technology transfer, a process that furthers adaptation and mitigation action while catalyzing sustainable development (Chile, 2015). This could assist in Chile evaluating and accessing lithium reserves for potential battery production, useful in electric vehicles and electricity storage. It is hoped that part of this technology transfer will be from Chile's intended participation in the SDM (Chile, 2015).

The Clean Development Mechanism (CDM) was very important for Chile's development during the Kyoto period. Chile was the sixth overall user of the CDM (Watts et al., 2015) and has publicized its support and effort towards CDM participation. Chile had a whopping 76 projects registered by 2018, 49 of which generated electricity from renewable energy sources, including major projects like the Atacama Solar PV Project that offered 250 MW of installed capacity upon completion (UNFCCC). This was very indicative of Chile's development strategy which planned to take on renewables in astounding amounts. With such intense CDM use, there was criticism that Chile's interaction with the CDM mimicked the "race to the bottom" anomaly, where host countries adjust their standards of sustainable development as to attract more foreign investment as the cheapest cost. According to this theory, the CDM could be used as a way to simply attract foreign capital (Rindefjäll et al., 2011). Some researchers argued that Chile was culprit of this, due to the fact that most of their favored projects centered on the "economic development" component to sustainable development, lacking the social benefits and multidimensionality that sustainable development investment should entail (Rivas & Cardemil, 2015). The projects grouped into the "economic development" category included things like renewable projects, landfill gas recovery projects and natural gas efficiency improvement projects. By having economic development qualities, renewable energy was tagged with this "race to the bottom" label, but this was partially without consideration for renewable energy's solar benefits like job creation, energy security, reduced air pollution and so on. In fact, of all of Chile's CDM projects, solar PV was shown to have the greatest number of sustainable development benefits of any project category (Cansino et al., 2018). It is also, in some ways, a testament to renewable energy's affordability and contribution, given that a true "race to the bottom" would seek the cheapest projects with the most emissions reduction ability. Nonetheless, it is very positive that the "race to the bottom" issue was recognized, as it has now been considered by the Paris Agreement and reflected in their current discussion of the SDM's design.

Renewable Energy Trajectory

The electricity generation mix as of 2017 was comprised of 23% natural gas, 15% oil, 21% coal, 28% hydropower, 2% biofuels, 4% solar and 4% wind (Norton Rose Fulbright, 2017). In the last decade, Chile has averaged 7% growth annually in renewable energy capacity (IRENA, 2017). As of this year, which began with a renewable capacity of 10,768 MW, there is expected to be up to 2,336 MW injected into Chile and operational by the end of 2018. In 2016, with 4% of its energy mix and 1,666 MW of installed capacity, Chile became the largest producer of solar energy in Latin America (Norton Rose Fulbright, 2017). Much of this was due to the recent, intense onset of investment, as Chile received 50% of the total investment in the renewable market for all of Latin America and the Caribbean (Norton Rose Fulbright, 2017). To keep up with the spurt in renewable supply, Chile contracted two foreign companies to build a transmission line between two of its disconnected grids, SING and SIC, allowing further penetration of renewables and offering cheaper energy options for all Chileans.

Wind has spiked in the last five years, taking on an enormous number of new projects with the help of the CDM and miscellaneous private investment. Most notably, wind energy amazingly tripled in one year, 2014, before piling on more growth to reach 1,421 MW by the end of 2017. As of late, Chile has been expanding at a rate of 500 MW every two years, indicating they are on track to reach their NDC goal of 2,000 MW by 2020 and silencing those voices that touted Paris's voluntary obligations as farfetched. Solar energy is experiencing similar growth, and Chile continues to prove that solar PV remains one of the most dynamic renewable energy technologies for spurring economic development and sustainable growth (Agostini et al., 2016). Solar hit 2,110 MW at the end of 2017, a remarkable feat given that just three years prior solar capacity had been 294 MW, and has therefore doubled three years in a row (IRENA, 2017). With the expected installation of more projects, solar should achieve its intended targets. Some of these include the 196 MW Romero Solar projects of Acciona, on track to cost $343 million USD and be the largest PV facility in Latin America There is also an astounding 743 MW project in the works, set to be one of the largest CDP projects ever and costing $2 billion USD. In comparison to solar and wind, hydropower's growth at this point is largely stunted. Because of the damage that dams cause, new project planning has shifted focus towards mini-hydro, having a smaller impact on the environment and disturbing local communities less (Norton Rose Fulbright, 2017). In hydro's heyday, many large hydropower projects had little recognition of local communities' needs – this type of conflict is not consistent with Chile's sustainable development goals. At this point, hydro's rather static existence is intended to provide diversification and backup for solar and wind intermittency.

No representation of Chile's expected energy trajectory is more vivid than the energy auction that took place in 2016, with bids for the 2021 energy supply. Based on the bid process, the electricity mix in 2021 will be 26% hydro, 16% gas, 14% wind, 18% coal and 7% solar. Not only are these number significant for renewables, the prices were as well. The average price of energy awarded was $0.478/kWh, 63% lower than the average price offered in the bid process just two years earlier. Renewables are expected to lower the energy prices 20-25%, representing $1.86 billion in savings for the final consumer (Norton Rose Fulbright, 2017). A solar bid received a 20-year PPA of $0.0291/kWh, the cheapest in the world for solar energy and making a case for renewables being affordable. The 2016 bid showed that coal was more expensive with a cost of $0.057/kWh, higher than solar ($0.029) and wind ($0.031). In fact, fossil fuels are so out of favor, the National Energy Commission doesn't even feature them on their short term node price for new operation, only showing activity from solar, wind and mini hydro (Norton Rose Fulbright, 2017). Factoring in the nation's carbon tax, the future for fossil fuels seems bleak. Nonetheless, they are expected to remain and slightly expand in the near future as Chile struggles to meet its newfound energy demand. With affordability, mitigation effects, social benefits and the ability to produce domestically, renewable energy, implementation is an unmistakable trend in the Chilean energy forecast, poised to capture increasing demand *and* the eventual void left by retreating fossil fuel producers.

Obstacles

There are number of hurdles that Chile must overcome if renewable energy is to become central to the country's development. Chile's grid is of concern: with such dramatic renewable energy expansion, there is suspicion that Chile's infrastructure is ill-equipped to accommodate the intermittent electricity generation that will be produced by solar and wind sources. Further investment is needed beyond the major grid connection project to limit congestion that would raise energy prices and eliminate the benefits of renewable energy. Having greater connectivity in the Andean electrical inter-connection system, which includes Chile, Colombia, Ecuador and Peru, could offer further outlets for Chilean production and could allow greater penetration by renewable installation (Cansino et al., 2018). Along a similar vein, an efficient storage system could become critical for proper allocation of energy. Utilization of Chile's lithium reserves has been a prospective option for decades, but now the technology and price points are finally reaching practical levels.

Socially, Chile must improve its project impact analyses. It has an Environmental Impact Assessment (EIA) system that must be carried out for any project and covers environmental and social impacts. This system has been successful is halting a number of major projects that would have harmed localities, including two 100 MW wind projects and one 2,750 MW mega-dam project in Patagonia (Agostini et al., 2016). However, existing deficiencies in its assessments have resulted in conflict between communities, the government and firms that all operate and have a stake in the Chilean energy sector. The transparency of the Chile's regulation needs revamping with better guidance to be offered for property laws, visibility of processes and respect for indigenous communities (Agostini et al., 2016). With proper adjustments in Chile's regulatory system and greater transparency of processes that yield desired outcomes, renewable energy could offer much more extensive benefits and eliminate more possible harms than it currently does.

Conclusion

Chile's actions to limit the main drivers of CO_2 have been impressive to say the least, and in terms of CO_2 emissions reductions alone, Chile is confidently on track to meeting its Paris commitments (Cansino et al., 2018). Paris's influence and Chile's complementary achievement are indicative of where the direction of the paradigm of development is headed. In the face of persistently increasing demand, Chile's actions towards renewable energy will supposedly be enough to overcome an infamous population and income effects that typically increase emissions through consumption (Cansino et al., 2018). What's maybe most impressive about Chile's ability to meet development with renewable energy is that it is in fact completely voluntary, instigated by Paris but not required.

Chile is a prime case study for renewable energy expansion for a number of reasons with the two resounding features being the intense economic benefits and development that renewable energy can offer, and the growing recognition and need for proper sustainable development policy to accompany it.

Chile is an example of a country that set standards in favor of privatization and solicitation of foreign capital. The government's primary participation only covers slim regulation of the energy market, project oversight and concession granting, and impressively this has resulted in exceptional investment in renewable energy, far beyond many of its neighbors and other countries around the globe. This is not an argument for privatization; rather, this is recognition of the transparency that privatization provides. Privatized interests are driven by factors of high profit, low costs and low risk, and in the case of Chile, these interests have very clearly favored renewables. Chile was a country that once had extremely expensive energy that was mostly imported. Now, with cheap and plentiful electricity production, the country produced an export of electricity to Argentina for the first time in 2016. This is just a taste of what could be expanded to Ecuador, Peru and Columbia, which would further incite participation from new actors with appetites for renewable energy. An economic study completed by Chile Renewable Energy Association revealed that a 20% penetration of non-conventional renewables by 2020 that was maintained until 2028 would generate $2.246 billion more in GDP than a business-as-usual scenario, offering more productive supply chains, reduced electricity costs, 7,760 new jobs, off-grid rural access to electricity, lowered imports and reduced pollution (Agostini et al., 2016). It is important to note that Chile has been lucky in its phenomenal solar and wind potential, which only adds to the idealism of it as an example. But nonetheless, Chile's ability to act on its endowment has been remarkable and speaks volumes to the ability of renewables to perpetuate growth without perpetuating emissions, acting as the skeleton for sustainable development muscle. Of course, connecting renewable energy to development will require a fine-tuned policy.

By retroactively analyzing Chile's interaction with the CDM, it is now clear that Chile fit some characteristics of the "race to the bottom" hypothesis, favoring cheap projects for energy sources that would allow emissions to be traded like an export, much like wine or fruit (Rivas & Cardemil, 2015). With such a heavy inflow of CDM projects, screening was deficient and some projects lacked focus on the social categories of impact, disadvantaging certain communities and not matching the principles of sustainable development. Simultaneously reflecting on the individual projects, we also now know that solar PV projects were the project type most indicative of sustainable development by offering multidimensional benefits (Cansino et al., 2018). This finding does not run counterintuitive to the "race to the bottom" hypothesis. Interestingly enough, it is not the renewable technologies themselves that are the problem, but rather the process of installation and operation, which in many instances lacked community consultation or extensive social impact analysis (Agostini et al., 2016; Cansino et al., 2018; Rivas & Cardemil, 2015). Regard for community interests, indigenous populations and transparency in the renewable development process will be critical points of growth for Chilean public policy. Although more thorough analysis may halt prospective renewable energy projects, recognizing faults in its social awareness is important for the sake of renewable energy adoption itself. As the process of renewable energy adoption is refined to become more aligned with the overarching goals of sustainable development, its implementation will be more widely accepted by communities governments, and firms, accepting the technologies as the new backbones of conscientious and multidimensional development.

Paris's focus has stressed this refinement (UNFCCC, 2016), arguing for increased participation from public and individual actors as well as the importance of choosing the right projects for the right countries. Chile has taken this policy shift to heart by increasing its national focus on transparent renewable energy development with explicit concern for community consultation, as outlined in its comprehensive Energy 2050 plan (Chile Ministry of Energy, 2016). As Paris continues to improve the SDM while guiding countries like Chile with principles of sustainable development, the international agreement is furthering the ability of renewable energy to produce social benefits and poverty alleviation beyond its recognized additives of job creation and energy security. Tackling renewable energy's possible fault and synergizing those corrections with its known economic and social strengths could gradually solidify renewable energy as a source of growth for developing countries that actively provides environmental, economic and social benefits in tandem.

From Chile's NDC: "Chile hopes to reduce its greenhouse gas emissions while decreasing poverty and inequality as well as continue advancing toward sustainable, competitive, inclusive and low-carbon development. To confront these challenges successfully, the country should direct all its domestic efforts and international alliances to decoupling economic growth from greenhouse gas emissions (Chile, 2015)."

Chile has launched into a space that few countries have ventured, by taking on serious renewable energy goals with real intentions of surmounting them. With hope for collaborative growth, transparency and refining of policy, Chile can hopefully decouple its development from emissions and set a strong example of what potential renewable energy sources contain while also acting as a guinea pig for refining the sustainable development pathway that is directly tied to renewable capacity expansion.

Bangladesh

Bangladesh is a tropical, low-lying country. It neighbors Myanmar to the southwest, touches the Bay of Bengal to the south and is blanketed by India to the northeast, north and west. Bangladesh is a Least Developed Country (LDC), a classification for countries with the lowest income and highest vulnerability (MOEF, 2015). Hungry for development, its recent growth has been remarkable. Even so, it lacks the social and economic characteristics of a middle-income country, a categorization Bangladesh hopes to achieve soon. With one of the highest population densities on Earth, meeting the mounting needs of the population will require directional, ambitious policy.

Bangladesh's location and topography have yielded it one of the most highly disaster-prone countries, and its delayed development has yielded it, consequently, highly vulnerable to these disasters. Seasonal changes bring cyclones, torrential rainfall and other extreme weather events that render the population and infrastructure at frequent risk (MOEF, 2015). Climate change is expected to increase the onset of disasters, as flooding, tropical cyclones, storm surge and drought are likely to increase in frequency and severity in the years to come. Long-term, rising temperatures, changing rainfall patterns, rising sea levels, tidal surges, salinity intrusion and ocean acidification will negatively impact the livelihoods of millions of people in Bangladesh. All of these natural threats hinder and counteract the positive socio-economic growth that the country has experienced in recent decades, impacting development across all industries from water to health, forestry, agriculture and infrastructure (MOEF, 2015). An example of disasters hindering growth is flooding in Bangladesh. Because nearly 25% of Bangladesh's territory lies below one meter above sea level elevation, the threat of flooding adds hesitation to the installation of sensitive renewable energy, which ultimately prevents development (Shiraiski, Shirley, Kammen, Huq, & Rahman, 2018). Capturing all of this, the Climate Change Vulnerability Index of 2011 revealed Bangladesh to be the most vulnerable country to climate change on Earth for the next 30 years (Mapclecroft, 2011), quantifying the enormous challenge that Bangladesh faces ahead.

Bangladesh's energy system is in need of improvement. The power supply is inconsistent and lacks coverage, which impedes national growth by being unreliable for industrial and commercial processes (Shiraiski et al., 2018). This, of course, is further exacerbated by the rate of natural disaster occurrence that degrades important infrastructure. As a symptom of this, more than a third of a population lacks access to electricity, a vital resource for social and economic development. This is largely due to the cost of extending the grid system, leaving many rural areas isolated (Komatsu, Kaneko, & Ghosh, 2011). In the face of this, Bangladesh has undertaken considerable action towards adopting a low-carbon development path, one that is backed by solar and wind power that remedies the energy issues faced in both rural and urban areas.

<u>Relationship with UNFCCC</u>

Bangladesh has subscribed to the tenets of the UNFCCC since its participation and in many ways has spearheaded the efforts that have come from LDCs. In the 2000s, the UNFCCC called on LDCs to produce agendas for implementation of adaptation and mitigation efforts. Bangladesh responded strongly and promptly with its "Climate Change Strategy and Action Plan" in 2009 created by the Ministry of Environment and Forestry (Haque & Huq, 2015), a plan that went above and beyond what would've been expected from the country. Bangladesh allocated $300 million to this comprehensive plan, supplemented by European contributions of $125 million (Haque & Huq, 2015). Acting as a leader of the LDC cause, Bangladesh has also taken a lead role in advancing negotiations over support for climate change loss and damage experienced by vulnerable countries. Bangladesh has put forth considerable effort towards this controversial issue and formed the "Loss and Damage in the Vulnerable Countries Initiative" in 2010 (Haque & Huq, 2015). This was in many ways a precursor to the "Warsaw International Mechanism for Loss and Damage" that was formed in 2013 at COP19, a mechanism and concept that has not gained traction. Bangladesh also explicitly subscribed to and met the "Lima Call for Climate

Action” (MOEF, 2015) at COP20, which expressed the need for countries to go above and beyond existing efforts with COP21 commitments (UNFCCC, 2014d). Bangladesh has been resolute in its support of the UNFCCC’s efforts to combat climate change, and this has been reflected in its leadership among LDCs and ambitious efforts to lower emissions and accept renewable energy.

Current Energy Situation

When thinking about the idealism of wide-scale renewable energy adoption, Bangladesh is an example of a country facing harsh realities. Between increasing population needs and natural disasters alone, the resources of the government are already stretched thin. Therefore, Bangladesh’s renewable energy policies have focused on selective-adoption of renewable options that yield the greatest sustainable development benefits.

The Solar Home System (SHS) program was adopted in 2003 with intentions of expanding off-grid solar energy. The government partnered with NGOs and private companies to offer small-scale, residential solar energy systems in rural areas that lacked electricity access. The program blossomed and at one point was the fastest growing off-grid solar program in the world (Shiraiski et al., 2018). This growth has continued since with 4.5 million installations as of 2017, generating a total of 200 MW of electricity.

Bangladesh’s “Renewable Energy Policy of 2008” was formative in the country’s renewable energy trajectory. The policy attempted to match the SHS’s success with success in the complementary utility-scale solar sector given that utility-scale solar has lagged behind. Its primary mandate was to encourage holistic renewable implementation, covering both rural and urban settings and through the use of public and private investment. The policy plan demands a 10% renewable energy market share by 2020 and references three motivations for such an adoption: The finite supply of fossil fuel availability, the need to cut global emissions to mitigate climate change and the need for energy security (Bangladesh, 2008). The policy also created a network of groups for collaboration on the issue. It established the Sustainable Energy Development Agency (SEDA) as a focal point for facilitating renewable energy development and promotion (Bangladesh, 2008). Assisting in this matter, the Local Government Engineering Department (LGED) was mandated to collaborate with the SEDA and direct focus towards renewable technology development. And finally, under the direction of the SEDA and the LGED, the Ministry of Power, Energy and Mineral Resources (MPEMR) was to dedicate itself to fiscal investment in renewables on a larger scale. Together, the groups could tackle the issue with a multidisciplinary approach that improved the due diligence process for renewable projects and better addressed the range of secondary impacts and benefits. The Renewable Energy Policy of 2008 was ambitious, especially with the glaring fact that at the time Bangladesh had a dearth of completed research on the nation's renewable potential, costs and benefits.

In conjunction with the Renewable Energy Policy, Bangladesh released its National Sustainable Development Plan (NSDP) also in 2008 (MOEF, 2008). The plan set the stage for long-term direction but still offered direct objectives as near as 2021. The NSDP outlined Bangladesh's development needs, particularly in relation to its explosive population growth and widespread poverty (MOEF, 2008). The written policy referenced *The Bruntland Report* and *Our Common Future* from 1992, echoing its designation of sustainable development as the new development paradigm.

In an attempt to increase the country's 77% electrification rate, Bangladesh committed to 100% electrification by 2021 in its "Electricity for All" campaign. This was to be done largely through its national grid, with hopes to offer reliable and affordable electricity access to all citizens (Shiraiski et al., 2018). To achieve this, the government initiated serious transmission line infrastructure expansions, attempting to create an electricity network with the breadth to serve countrywide demand.

Bangladesh intends on achieving the classification of a middle-income country by 2021 with a current growth rate that makes its goal seem a near reality. Bangladesh is currently experiencing a growth rate of 7% annually and, in 2016, was the second fastest growing major economy in the world (Shiraiski et al., 2018). Electricity demand has outpaced this GDP growth, growing at an astounding 13% annually. To meet this demand, Bangladesh tripled its installed capacity between 2009 and 2017 to reach 16,070 MW (Shiraiski et al., 2018). As of now, Bangladesh models that the future trajectory of energy demand will be just as intense.

Nationally Determined Contribution

The NDC for Bangladesh respects common but differentiated responsibilities, but also takes large strides for an LDC. The unconditional commitment for Bangladesh is to reduce greenhouse gas emissions by 5% from business-as-usual by 2030. On the condition of support in the form of finance, investment, technology transfer and capacity building, Bangladesh will reduce its emissions by 15%. AFOLU activities are not factored into its commitments due to the unavailability of national data for modeling (MOEF, 2015). For the energy sector specifically, the intended goal is an unconditional 5% reduction and a conditional 18% reduction. More specifically, Bangladesh hopes to reduce its energy intensity, in terms of its GDP, by 20% by 2030 compared to 2013 levels.

Even with an uphill battle against the negative impacts of climate change and the country's security questions, Bangladesh remains committed to the global effort of limiting the globe's temperature increase to 2°, with hopes of 1.5° (MOEF, 2015). This commitment is part of the country's dedication to evolving into a low-carbon economy. Bangladesh's prime minister has asserted that the long-term goal for per capita GHG emissions is to not exceed the average for developing countries. This allows Bangladesh room to grow as the country zeroes in on a development pathway that doesn't revert to traditional patterns of GHG emissions production.

Without domestic or global action, due to climate change impacts, Bangladesh could lose as much as 2% of its GDP annually by 2050 and 9.4% of GDP annually by 2100 (MOEF, 2015). This is a lot to lose for a country that needs considerable growth to support its population. In response, as described in its INDC, Bangladesh plans on enhancing its adaptive capacity for the sake of preserving economic progress and protecting the wellbeing of the population (MOEF, 2015). Enhancing the country's resilience is centered around target issues like food control, water security and urban resilience, but is also innately tied to energy policy due to the benefits that renewable electrification can add, decentralized or not (MOEF, 2015).

Bangladesh's approach to mitigation activities in its NDC is focused on three sectors (energy, transport, and industry) that are most specifically in line with the national development plan (MOEF, 2015). This is positive in demonstrating the strong interplay between national growth and mitigation; the weighted contribution of the energy sector (18% sector reduction compared to overall reduction of 15%) is telling. In line with the Renewable Energy Policy of 2008, the NDC will "maximize" renewable energy sources to lower GHG emissions and ensure energy security with a near-term target of 10% market share by 2020 (MOEF, 2015). The NDC addresses the co-benefits of energy-related mitigation activities, calling on improved air quality, deployment of green jobs, cost savings for families and improved access to energy (MOEF, 2015).

Bangladesh has noted that it will be keen on taking advantage of the SDM and its development benefits (MOEF, 2015). At the time of Kyoto's CDM, Bangladesh was just beginning to transition its concentration towards renewable energies and maintained only moderate openness to foreign investment. Consequently, its use of the CDM was very limited, only producing six registered projects. One project was a biomass thermal energy project, producing 16 MW of energy (UNFCCC, 2018). But otherwise, very little energy production came of the CDM – most of the projects were intended to capture specific emissions leaks or improve energy efficiency (UNFCCC). With more receptiveness to foreign investment, the SDM could play a focal part in Bangladesh's sustainable development trajectory as was the case for close neighbors India and China. Along the same vein, the NDC stressed Bangladesh's receptiveness to financing from the Green Climate Fund (MOEF, 2015), adding to the opportunity that Paris may be able to provide.

Renewable Energy Trajectory

Some interesting parts to Bangladesh's current electricity mix include 53.63% natural gas (8,530 MW) as the majority holder, 17.12% furnace oil (2,629 MW) with a large stake and 1.53% coal, on the very low end of typical production. Renewable energy has only a 3.1% stake in electricity production (505 MW). Solar comprised 53.7% (272 MW, 255 of which was off-grid) with hydro next with 45.5% (230 MW) and wind following with 0.6% (3 MW) (SREDA, 2018). Renewables are far from their goals of 10% (2.4 GW) by 2021 and 20% (7.8 GW) by 2030. As of 2016, a large majority of Bangladesh's electricity comes from fossil fuels, mostly natural gas.

Energy demand growth has never been stronger. The three dominant sectors of power, transport and industry are expected to grow in energy demand by 264% by 2030 and could represent as much as 69% of total GHG emissions by that time. This energy shortage is compounded by the population's demand, which outreaches supply and results in over a third of citizens living without electricity access. In order to meet these pools of demand, Bangladesh's generation capacity is projected to expand from 12,365 MW in 2016 to 24,000 MW in 2021, and eventually to 39,000 MW in 2030 (Shiraiski et al., 2018), a tall order for the country.

Bangladesh's needs as an LDC are strenuous. With such urgent needs, fossil fuels are expected to be an important contributor to utility-scale energy growth. Natural gas produced energy is expected to take a backseat in the near-future, dropping in market share by nearly 20%; but, there are still plans in the works for at least one combined-cycle power plant – a technology that is intended to offer cleaner fossil fuel-based energy (MOEF, 2015). In addition, coal will be featured in the near future, with an estimated $16.5 billion to be spent by 2030 on adapting all coal production to have "super-critical" coal technology, a feature that improves efficiency and reduces emissions output (MOEF, 2015). The total growth in coal production could be as much as 13.3 GW in 2030, amounting to about a third of Bangladesh's total energy. This is no small amount and will increase foreign dependency on raw energy imports considerably. However, this subscription to fossil fuel energy is expected to be temporary and will not be nearly as significant as what countries like the United States and Britain took on in their respective historical developments. Matching the trajectory of fossil fuels, Bangladesh has taken on ambitious plans for its renewables expansion. The country has expressed its desire to reach a 100%

renewable energy future as rapidly as possible, although no specific plan or timeline has been provided. It is with hope that, as the price of renewable energy steadily falls, this goal can overcome peripheral status. Currently, the average cost of electricity from the grid is $68/MWh (Shiraiski et al., 2018). Renewable are nearing this range but are still lacking direct competitiveness.

Wind is on the cusp of popularity with 400 MW of wind generating capacity expected by 2030 (MOEF, 2015). To meet this goal, Bangladesh is injecting $600 million into the industry. However, there is no intention of wind becoming a majority holder to Bangladesh's energy system with a limited potential of only 5% of current peak demand (0.57 GW). In addition, wind's costs fall outside of current grid pricing with a range of $99-$108 USD. This range may not be currently competitive but is still promising by undershooting coal ($110/MWh) (Shiraiski et al., 2018). In this way, although its potential may be limited, wind's cost effectiveness could make fiscal and foreign investment attractive.

Solar is, thus far, destined to be the most viable renewable option for Bangladesh. The NDC expects to install 1000 MW of utility-scale solar power by 2030, spending up to $1.3 billion over the course of 20 years (2011-2030) (MOEF, 2015). In addition, Bangladesh plans on investing $1.22 billion in solar irrigation pumps, solar micro-grids and solar nano-grids (MOEF, 2015). Both of these investments would complement the energy already supplied through the residential

SHS program, building a solar energy system that offers citizens a variety of solar options to fit their needs and income.

The reasons behind Bangladesh's strong solar interest are its availability and affordability. There is very extensive national utility-scale solar PV potential (53 GW), more than enough to meet the nation's demand. For comparison, large-scale PV has costs lower than coal power, falling around $91/MWh with coal at $110/MWh (Shiraiski et al., 2018). Large scale CSP is inching towards competitiveness. The cost of CSP without storage is currently $127-$160/MWh; with storage, the cost is $237-300/MWh (Shiraiski et al., 2018). The emerging cost effectiveness of PV and CSP is a large reason behind the government of Bangladesh's target for utility-scale solar, independent of its NDC, that hopes for 7.8 GW of utility-scale solar (Shiraiski et al., 2018).

Rooftop solar is a becoming much more prevalent in Bangladesh in the past decade, thanks to the SHS program. Although rooftop produces less energy and costs more than utility PV, is serves a very different purpose. The SHS program was designed to reach communities that would not receive grid connection within 5-10 years (Komatsu et al., 2011), helping to tackle the significant lack of electrification. The potential is large with a capability of generated 17% of current peak demand (2 GW). This has begun a period of realization where 4.5 million homes have now bought into the program. At face value, one would be deterred by the fact that the cost of residential solar falls around $244/MWh, nearly double large-scale PV or coal. However, the true costs are only marginally higher relatively, due to the serious costs that would have to be incurred to expand the existing grid and its partnering infrastructure (power stations, sub stations, transmission lines) (Komatsu et al., 2011). Supplying communities with rooftop solar energy will allow grids more leisure in their expansion and will hopefully allow further grid-penetration by renewables before extending to reach new sources of demand.

The SHS program has nestled in nicely with the country's long-term plans for sustainable development, demonstrating the range of social, economic and environmental benefits independent solar energy can offer. One such factor is climate change adaptation, which has been greatly improved, as micro-solar can prevent electricity loss in the instance of natural disasters and grid damage. This is a significant factor for a country that ranks as one of the world's most vulnerable to natural disasters. Another benefit of residential solar is space preservation. Agriculture is an important economic industry and highly necessary for feeding a growing population. There is innate conflict in that high solar energy potential areas often coincide with agriculturally productive land; residential solar, avoids this quarrel.

On an individual level, the quality of lives of the SHS program participants has been dramatically increased. Electric lights are enabled, allowing extended hours for study time and work time; this benefits education and productive capacity, two factors key to sustainable development (United Nations, 2015). The electric lighting replaces kerosene lighting and, in doing so, improves indoor air quality and limits residential GHG emissions. With electricity, houses have access to entertainment and news through television. Users can recharge their mobile phones easier without having to travel to a market or friends house. Incidentally, the number of mobile phone owners has increased in areas with the SHS program implementation. All of these underlying benefits, and more, are received by residential solar users What is most impressive is that this quality of life improvement has come at nearly no emissions cost to the earth.

The costs of rural electrification through the SHS program are manageable enough that they outweigh the costs of grid expansion in many cases. Although costs of PV are tumbling at high rates, the upfront costs can deter rural households. To aid this, SHS project upfront costs are diminished to 15-25% of the total price with a 2-3 year repayment period at a low interest rate (6-8%) (Komatsu et al., 2011). As another option, a household can pay the upfront cost in full and receive a 4% discount. Offering discounted options has been positively received, as evidence of the 4.5 million current installations. Further natural solar cost reductions could have very strong effects on solar uptake. As proof of this, in a survey nearly 61% of non-SHS households reported they would desire purchasing residential solar if the price dropped just 10%. This price drop is not out of line with global trajectories (Agostini et al., 2016). In fact, with a price decrease of 30%, demand for solar would actually shift to favor the larger MW packages that the SHS program offers and further the degree of rural electrification (Komatsu et al., 2011).

For daily use, SHS electricity was a clear preferential alternative to the typical energy sources of kerosene and batteries. For kerosene, its purpose was largely for lighting and cooking. Costs came in the form of purchase cost, transport costs and the lost time from traveling to a market for refilling. With SHS, three-fourths of households dramatically reduced their kerosene use and nearly half of households stopped kerosene use altogether (Komatsu et al., 2011). Rechargeable batteries are largely used for charging phones and operating low-consumption electric devices. The costs of use are recharging, transporting and lost time (the batteries often take 2 days to charge). After SHS installations, only 3% of houses retained use of batteries, saving time and money (Komatsu et al., 2011). Together, the savings on kerosene and recharging amount to 30% of the monthly SHS costs, without consideration of the fact that within three years the solar costs would be eliminated entirely when the system is paid off. Combining all of this, implementing solar and eliminating its alternates results in the elimination or reduction in perpetual energy cost, travel time for retrieval, transportation cost, poor indoor air quality, poor lighting and residential GHG emissions, among other things. All of these positive development benefits will become even more accessible as the price of solar energy falls and rural areas seek higher adoption rates for rooftop solar. Bangladesh plans on playing on the strong reception that the SHS program has experienced and improving the nation’s electrification rate through low-carbon means.

Obstacles

To feed its inflating population of 165 million people, Bangladesh must make thoughtful, farsighted decisions about its land use. Cropland is a vital part of Bangladesh's economic and social vitality, and there must be a proper balance in priority between renewable energy and agricultural land. Some concepts suggest that solar panels and crops or fish farms can be interspersed, much like intercropping, in a way that maximizes space for both (Shiraiski et al., 2018). Solar PV requires 5.6 times the land use of coal-fired power, so solutions like "intercropping" may be necessary for expanding renewables while respecting valuable agricultural productivity.

Grid infrastructure is lacking for effective utility-scale solar use. With a farther-reaching grid connected to more communities and demand, added supply from solar could more readily compete. Ideally, long-term, a feature of this infrastructure would be electricity storage, because solar PV generation patterns do not match up exactly with peak electricity demand in the evenings (Shiraiski et al., 2018). In the short-term, storage wouldn't be necessary because solar comprises such a small contribution – anything past a 20% market share becomes an issue (Shiraiski et al., 2018). This distant threshold is advantageous; it won't be reached for some time and therefore allows the price of electricity storage technologies (batteries and air compressors) to continue falling before the need to invest in Bangladesh's later stages of renewable development.

Conclusion

Bangladesh is attempting to balance a plethora of circumstances: daunting adaptation needs, a trajectory towards becoming a middle-income country and the desire to limit its GHG emissions. This is an extremely vivid example of a low-income nation with many obligations and minimal responsibility for climate change that is still willing to lower its emissions in spite of development desires.

Bangladesh's relationship with coal is ambivalent. There is no denying the country's continued need for fossil fuels, as many countries before it have demonstrated, but Bangladesh is also undertaking highly-intentional capital allocations towards lowering the environmental impact of coal through energy super-critical filtering. Given the statutes laid out by the Paris Agreement, this move is, in truth, unnecessary by an LDC, but indicates that Bangladesh doesn't emit without recognition of climate change. This is furthered by their commitment to renewable energy sources, which have offered development and adaptation benefits through energy diversification and cost-effectiveness. Bangladesh's perspective is forward-looking and its recognition of development's shifting characterization is no more visible than in its long-term expectation of 100% renewable energy production. The development process of Bangladesh has diverged greatly from the traditional patterns undergone by western Europe and the United States and will continue to act in accordance with sustainable development in a manner that is both virtuous and economical.

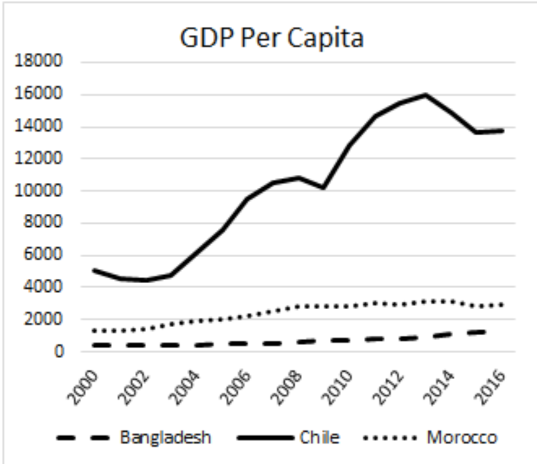
Bangladesh is a good example of adaptation and mitigation in balance, the former of which is more urgent in nature. Synergistic strategies like rural electrification and mini-grids service themselves as mitigation *and* adaptation strategies, offering a sum of benefits greater than their respective parts. Coal has very few adaptation perks, especially due to its supply chain vulnerability in times of disaster. Energy sources that don't exemplify these vulnerabilities while conversely adding to adaptation measures would be highly useful for a country in need.

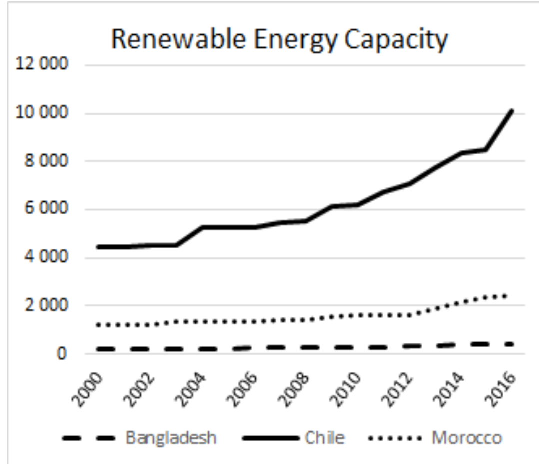
The proactive nature of Bangladesh towards low-carbon development is most tangible in its SHS program. Rural electrification though affordable solar energy is beyond the scope of coal's potential in many ways. The SHS program has lower costs relative to fossil fuels, when considering grid expansion costs, and simultaneously provides scores of benefits for social development and national progress. Already, 4.5 million homes have a source of clean electricity where there was no electricity access just over a decade ago. By skipping the fossil fuel phase of electrification, 4.5 million homes now provide a collective example of what the new development paradigm could resemble. In fact, electrification through the SHS program not only skipped traditional fossil fuel reliance but achieved electrification faster without it. The SHS program accelerated development, rapidly raising communities' quality of life through increased productivity and education, among other things, while decreasing the negative externalities of indoor air pollution and the opportunity cost of time loss. Beyond all of this, as demonstrated by the success of the project, the energy sources were affordable, which is a strong statement given the poverty in the designated rural areas.

Bangladesh's national situation as an LDC with high vulnerability yields a need for growth. Some of this development is through the avenue of coal power, and some is through renewables, but the fashion through which Bangladesh pursues both represents a shift the traditional pattern of development. Its pursuit of coal expansion is intended to be ephemeral and with reduced impact. It pursuit of renewable energy is intended to proactively displace the need for fossil fuels in many areas from the onset and push the country close to 'electricity for all' by 2021. The country is going far beyond its requirements given its standing; this is indicative of its willful embrace of Paris's mission and the new paradigm of multidimensional, renewable-backed national development.

Case Study Discussion

All three countries have demonstrated positive elements of renewable energy adoption and are highly explicit in their goals to forward the cause. These three serve as representatives for an array of national qualities and outcomes, offering clear distinctions that capture the spectrum of circumstance and actions within the larger development movement.





Gross domestic product (GDP) per capita, as shown in the figure above, is a telling comparative indicator for renewable energy progress. Chile has had a clear head start economically, due to its recent high foreign investment reception and mining sector profitability. Morocco sits in the middle on economic maturity, both in terms of national growth and renewable energy investment. Bangladesh is on the early end of development and renewable energy capacity. However, the order for future growth prospects is flipped. Chile has experienced an economic slowdown recently, Morocco has been riding a steady updraft of growth in both departments and Bangladesh is poised to catapult itself into the middle class and increase renewable investment. These rankings for GDP per capita are not only indicative of renewable capacity investment but an inverse for vulnerability, as is clear with the example of Bangladesh. The hierarchy of economic growth between the countries is palpable across numerous other indicators like renewable energy prices, CDM involvement and NDC commitments. Their tiered consistency across multiple indicators provides a useful conceptualization of a development spectrum, one that other countries fit into.

Each country has influenced and experienced reductions in renewable energy costs. Chile has now achieved the lowest photovoltaic solar energy prices in the world at $0.029/kWh, undercutting coal through strategies of free-market, competitive investment. Morocco is not far behind with photovoltaic solar energy costing $0.058/kWh, with its use of economies of scale and Independent Power Producer efficiencies. The cost of solar in Bangladesh is $0.084/kWh, three times the cost in Chile, representative of its limited efficiency and expertise, as well as its less favorable solar thermal endowment. The price levels may differ, but there is commonality in their direction (downwards) and subsequent impetus for investment (upwards).

CDM participation was highly correlated to each country's level of acceptance of foreign investment and offers an interesting prospection of participation in the impending SDM. Chile's portfolio (76 projects) was dominated by renewable energy projects (66%), but its appetite for CDM investment was so large that maximum co-benefit generation was not always ensured. Morocco's engagement with the CDM (11 projects) was more limited but demonstrated the range of benefits renewables like solar offer (Karakosta et al., 2013) for economic prosperity, employment and fossil fuel reduction. Bangladesh's participation is minimal if benchmarked to Chilean standards, capturing limited investment (six projects) and generating limited energy.

CDM participation by country can be analogized to renewable energy prices – clearly tiered but with a common forecasted directionality. In all of these countries, the SDM is expected to have greater impacts per project. The impact of the SDM should be more purposeful than that of the CDM, between factors like Chile's reevaluation of project impact analysis and Morocco's proof of co-benefits, directing the countries foci towards more holistic project choices. This refined use should be complementary to the increased adoption of the SDM, as all three countries have explicitly expressed their intent on increasing participation, particularly Bangladesh and Morocco.

The countries' NDC commitments are astounding given the nature of their historically delayed development, in some ways outreaching the goals of developed countries. For developing countries, the aspiration to achieve 20% total capacity from renewables in 2025 (Chile) or 2030 (Bangladesh) or an astounding 52% by 2030 (Morocco) are far beyond anything that could've been expected at Kyoto and unthinkable previous to that. Putting such ambitions in ink for the world to see and judge is clear indication that the norms of development have certainly changed.

Although the disfavoring of fossil fuels and emphasis on renewable energy capacity growth can come from private investment and market preferences, as is the growing case, government initiative is also a critical catalyst for renewable energy's expansion in countries. Each of these countries has a unique strategy for renewable energy investment that falls somewhere between required, public initiative and free market, private direction.

Chile's approach has been one that leans heavily towards privatization and reception to foreign investment. Its appetite for foreign, renewable investment has ultimately led to it becoming a country of extremes. On one hand, the country has checked every box of achievement for renewable adoption; it has decreased its cost of energy, produced the lowest global solar prices, outpaced its continent with renewable adoption, decreased its import burden and energy insecurity, created jobs and generated a forecasted $2.2 billion GDP boost due to renewable expansion. Concurrently, however, its rapid renewable adoption rate outstripped policy expansion. During the CDM period, for instance, non-transparent regulatory frameworks lacked scrutiny for social and environmental impacts, underestimating community needs and resulting in marginalization of populations, some of which are indigenous. Chile is an illustrative showcase for the intense economic benefits that renewable energy can provide and attests to its potential to serve as the backbone of development, but separately calls on the need for its fusion with sustainable development philosophy, one that espouses more collaborative, equity-based development with equal concern for economic, social and environmental effects.

Morocco's policy approach to propelling its renewable-based development is slightly different, as exemplified by its buy-own-operate-transfer (BOOT) strategy. Morocco has followed the general trend towards liberalization much like Chile but to a lesser extent. The BOOT strategy has disrupted the Moroccan national energy monopoly, but has not turned over the entire energy system to private or foreign hands. The BOOT structure allows the government to advise, monitor and maintain partial ownership over its renewable energy projects, but still encourages more efficient, affordable construction and operation of renewable plants through private control. The clever tactic of risk spreading has invited private investment, injected new foreign capital, transferred technology and know-how, increased the ability of projects to be timely and released the burden for the public budgeting and infrastructure build process.

Bangladesh provides a very different example because of its status as one of the most vulnerable countries in the world. This vulnerability will require extensive focus on adaptation; between this and the fact that Bangladesh produces only 0.35% of global pollution, mitigation and renewable energy, in theory, should be peripheral foci. Instead, Bangladesh has undertaken more than its responsibility would suggest. The Solar Home Systems (SHS) program is thus far one of the most interesting initiatives, spurring rural electrification at a rate faster and cheaper than traditional grid infrastructure expansion could offer. The SHS program has demonstrated that adaptation and mitigation can be conjoined and doubly effective through renewables, which offer electricity to communities even in times of disaster without prevailing grid failures or blackouts. The program is primarily government-supported but has partnered with non-governmental organizations and private companies. The program provides a very unique example of communities adopting renewables from the onset of electrification while skipping the traditional fossil fuel phase of development that has been a dominant model for so long. Subsequently, the results have been impressive – improved productivity, education, health and lifestyles, all with affordable costs to families. When considering this and its underlying national circumstances, Bangladesh may actually be the most exemplary country of the three for offering a look into the future. Bangladesh's threat from climate change is currently very high but not beyond that which is forecasted for others. With this impending climate threat, Bangladesh has demonstrated the ability of renewables to offer adaptation benefits in addition to mitigation benefits and has done so in a way that replaces the need for increased use of fossil fuels. Bangladesh may not have tackled utility-scale renewables at the scale of Morocco and Chile, but it certainly has a unique angle that provides extremely positive development impacts across sectors.

The variation in these countries' economic standings, renewable implementation policies and international agreement ambitions can all be explained by a variety of motivations that could be important features of long-term domestic and international policies moving forward. These features have not only been considered by the Paris Agreement but actively addressed by it, improving their domestic capabilities for building on their renewable energy capacities and bringing these countries' future NDC ambitions into reality.

Collaboration. Collaboration across international lines makes renewable investment less cumbersome and more synergistic. All three countries have adopted policies and practices that have benefitted them through cooperation with private partners, nongovernmental organizations and other governments with differing expertise and resources. The Paris Climate Agreement is incisive on global-scale collaboration, encouraging partnership through the SDM and linkage mechanisms while simultaneously serving as a partner itself by providing oversight, monitoring and guidance for countries like Morocco, Chile and Bangladesh. Cooperative effort, by design, is a creator of collective belief, something that is crucial to the formation of a true, universal paradigm shift.

Affordability. The general trajectory of renewable costs is downwards, and its acceleration only feeds back into its investment rate and further affordability. In this way, affordability is both a symptom and cause of renewable energy becoming the backbone of development. The "symptom" of its newfound role is the focus that has been placed on it, due to the impending crisis, which has encouraged research, technology expansion and economies of scale - all factors that have lowered the price. A "cause" of its new responsibility is that renewables are more heavily adopted with further affordability. All three countries recognize the accelerating affordability of renewable energy and simultaneously supported the trend's continuation with appropriate policies that have widened its scale, replaced unnecessary fossil fuel costs and increased its competiveness. A central tenant of the Paris Agreement is technology development and transfer, a critical element of cost-effectiveness. All three of these countries have emphasized their desire for effective technology dissemination in their NDCs, doubling the push for progress in the area.

Co-benefits. The desire for higher wealth and prosperity is a deterrent factor in all three countries' decision making, and holistic growth towards better health, education and poverty alleviation are priorities comparable or even greater in some cases than the energy supply. Renewable co-benefits, however, help alleviate the stress of countries having to balance priorities and resources. The long-term remission of local pollution, adding to the national GDP, improving the resilience of communities and reducing supply-chain and import reliance are all provided by the singular act of renewable energy investment. To favor fuels that not only lack those co-benefits but act inversely to increase health issues, perpetuate climate change impacts and rely on extensive supply chains would be shortsighted. Paris's stress on sustainable development and denouncement of fossil fuels are central to these co-benefits. Decoupling emissions for growth while generating widespread benefits is far more advantageous to countries with welfare improvement needs.

Obstacles. To deny that there are obstacles to idealized, universal renewable adoption would be remiss of the realities of its gradual process. Infrastructure improvement is critical to these countries' wide-scale use, which also includes the need for battery storage in the near future. Paris's correct project due diligence is also a necessity, as Morocco and Chile must ensure positive multidimensional benefits and Bangladesh needs to expand its information system to better understand points of conflict and benefit.

Funding. Funding is a critical piece of the puzzle as demonstrated by the countries' conditional NDCs, and the international community must provide substantial financial support for universal mitigation objectives to be achieved. The more investment that goes into renewables now, at the beginning of these countries' developments, the earlier in the process that national growth becomes structured around renewables. The longer that renewables are delayed and the more that permanent fossil fuel infrastructure is built, the harder it will become to break the encasing of high-carbon energy reliance. Developing countries with emerging economies are on the cusp of becoming either intense polluters or renewable energy flag bearers. A rapid flow of finance towards renewables in the near term is highly necessary and beneficial in the long-term, and this is tackled by Paris's fundamental principle of financial provision for developing countries.

Trajectory. Through the NDCs, national energy plans and current actions, there is a clear theme. All three of these countries have declared strong intentions for a movement away from the dirtiest fossil fuels. This trajectory requires realism about the countries' dire energy needs and infrastructure limits, but the general direction is unambiguous. Although the paradigm for decoupled growth is still in its formative stage, its blossoming acceptance is certainly palpable.

The analysis of these three countries provides a unique look into the interactions between national circumstances, independent policy and international agreement influence. Each of the three has differing strategies for renewable adoption and differing subsequent faults and advantages. With Chile's privatization, Morocco's public-private investment and Bangladesh's rural electrification program, much of what each policy lacks could be supplemented by another. Understanding these countries' differentiation across factors, a spectrum is formed that can capture other developing countries' situations and trajectories within it. Interestingly enough, even with such differing characteristics, each of these three countries have all assumed an approach that seeks growth in tandem with increased energy independence, decreased pollution and greater social/environmental responsibility. In addition, the collaboration, direction and support that the Paris Agreement provides has bolstered these countries' initiatives, providing a framework for each to increase the ambition of their renewable energy trajectories. By finding this common renewable energy trajectory with the spectrum formed by Morocco, Chile and Bangladesh, the platform can be extrapolated to wager that there are strong movements in the developing country sphere, regardless of national circumstances, that all favor a renewable energy future and have been catalyzed through Paris's direction. By demonstrating a common will to favor the new development paradigm and the decoupling of emissions and growth, there is evidence that national development is dramatically changing for the better, in large part, due to the drive of the Paris Climate Agreement.

Conclusion

Humankind has witnessed two historical energy crises, both due to overreliance on a narrow set of energy sources, both posing as possible perils but both being eventually solved through global transition. We now face a third crisis due to our excessive combustion of fossil fuels and associated greenhouse gas emissions. Much like our historical overreliance on, first, the passive solar system and then on the agrarian energy system, we have abused the availability of hydrocarbons and are now confronted by crisis. Solving the energy crisis will require shifting our reliance from overused sources, fossil fuels, in favor of a new backbone, renewable energy, that will propel future growth and prosperity. This transition will not only require considerable time, innovation and investment, but a fundamental shift in principle toward a new paradigm of development that decouples economic growth from fossil fuels and greenhouse gas emissions.

Identifying humankind's third energy crisis has been a responsibility undertaken by science, and its process has been prolonged. Over the course of its recent history, climate change science has continuously fought an uphill battle against technical limitation, skeptic opposition and partisan negligence to act. Progress has been arduous, but global collaboration and international support have overcome hurdles that once seemed insurmountable, yielding scientific clarity. This process has culminated with the diagnosis of crisis; scientific consensus has identified the issue at hand, climate change, and confidently attributed its cause to the overuse of fossil fuels. Although seemingly belated in its arrival as we are now closer to the planet's brink point than ever, crisis recognition has been timely enough for survival and has galvanized a resounding reaction from policy in search of a solution.

Climate change policy has grown in tandem with scientific confidence; as clarity has been added to the issue, so too has clarity illuminated the solution. Following similar timelines, the development of climate policy has been distinct but innately tethered to that of science. Unlike the solidification of science through technical advancement and academic undertaking, contemporary policy has been largely shaped through diplomatic deliberations and multilateral consensus building. Reflection upon the successes and failures of milestone agreements reached in Montreal, Kyoto and Copenhagen has allowed for reevaluation and redirection of international climate change policy for the better. Furthermore, the protracted and often confrontational negotiation process has been continuously insightful for weighing national priorities and designating responsibilities between stakeholders. This internal improvement process that policy has undergone has been complemented by interdisciplinary science, which has provided overarching direction and motivation. Now, the two disciplines have coalesced with their most ambitious product yet, the Paris Climate Agreement.

The Paris Agreement has conjoined climate science's urgency with international policy's pragmatism to endorse global, calculated action. The Paris Agreement's unprecedented impetus to act is demonstrated by the scale of its near unanimous acceptance. The virtually universal adoption of Nationally Determined Contributions (NDCs) is a landmark victory for climate change policy, as all countries, including developing countries absolved of responsibility, have offered commitments to actively combat climate change. Voluntary action has even reached beyond the government level, as the Paris Agreement has spurred public-private partnerships with commonalities between national objectives and market interests. Because of the Paris Agreement's ability to garner such wide-ranging support, the momentum behind resolving climate change has never been more avid, the support system more complete and our action to reduce fossil fuel emissions so tangible.

One must not neglect to mention the setback in universal momentum caused by the United States, whose withdrawal has rescinded its commitment, funding and partnership. Being a major global emitter, its unwillingness to cooperate will surely hinder, if not counteract, some of the gains that the Paris Agreement will generate. Driving the United State's withdrawal was the Trump Administration's belief that limiting fossil fuel usage bears "economic disadvantages." This assertion indicates that the Administration has oversubscribed to an antiquated line of thinking, one where economic growth is inseparable from and dependent on hydrocarbon resources. It is in response to this assertion that the Paris Agreement shines; to reciprocate its denunciation of our current energy reliance, the Paris Agreement has built the scaffolding for a forward-looking exit strategy, one that offers countries a new resource to be dependent on, renewable energy. The reality of this exit strategy was explored and captured through the ground-level analysis of three developing countries, whose economic status and participation display the heart of the movement itself.

The individual case studies detailed two different accounts, 1) what each country is achieving domestically, and 2) how the Paris Agreement has catalyzed each country's actions. Domestically, all three countries demonstrated a range of circumstances with differences in gross domestic product per capita, population growth rate and level of vulnerability, and yet all maintained commonality in their long-term energy policy, edging fossil fuels aside for a renewable energy focus. There are many obstacles to this idealized pathway and each country's specific policies were prescriptive to their capabilities and needs, but all still shared the common thread of renewable energy capacity expansion, recognizing the resulting co-benefits generated across social, environmental and economic sectors.

With the advent of the Paris Agreement, each of the countries magnified their long-term ambitions in favor of renewable energy. Each country's first-ever NDCs were evidence of this, putting forth declarations of intent to accelerate domestic and global transition. Dissections of the countries' NDCs revealed a number of shared priorities between the countries, priorities that matched global trends and were explicitly met through contributions from the Paris Agreement. Among these was an interest in increased renewable energy affordability, a necessary factor for unindustrialized countries adopting new technologies. The Paris Agreement targeted this concern with the implementation of the Sustainable Development Mechanism and technology transfer mechanism, both of which compound the current, natural rate of cost reduction and dissemination of renewable technologies. A second shared priority was cooperation across international lines, a factor that makes renewable implementation less cumbersome and more synergistic. The Paris Agreement supported this need by encouraging international partnership through the Sustainable Development Mechanism and linkage mechanisms, while simultaneously serving as a partner itself through oversight, monitoring and guidance for NDC compliance. Financial backing was another heavily weighted need, due to its ability to fill the void in less-wealthy countries' domestic funding capabilities for renewable energy investment. In an attempt to match this need, government and corporate sponsors, through Paris's request, pledged financial contributions to be allocated toward developing country renewable energy projects. By considering and explicitly targeting these common priorities, the Paris Agreement has galvanized action in developing countries, doing so with assurances of long-term accountability.

The accelerated global adoption of renewable energy and paralleled disavowal of fossil fuels by the Paris Agreement and the three countries reflects that a paradigm shift is not only underway but proliferating. This new paradigm subscribes to decoupling economic growth from fossil fuel-derived greenhouse gas emissions, divorcing two things that have been seemingly inseparable since the Industrial Revolution. This alternative, energy-specific model for development has been indirectly promoted by the Paris Agreement's propagation of sustainable development, an umbrella concept of holistic policy construction across all sectors. For Morocco, Chile and Bangladesh, the synthesis of their national energy circumstances and energy policies forms a spectrum for countries dispersed along the development pathway, capturing a wide variety of characteristics and countries within it. By building this wide platform, the case study results can be extrapolated to represent not only other developing countries, but the greater movement away from antiquated fossil fuel dependence and towards the new paradigm. We are entering a period in time, with the help of the Paris Agreement as a starting point, when less-developed countries now have the unprecedented opportunity to bypass the traditional fossil fuel growth phase in favor of co-benefit generating energy sources with less damming future implications. It is now clear that the longevity of the planet's stability does not need to be compromised in the pursuit of economic prosperity.

Decades of globally concerted effort towards uncovering humanity's third energy crisis have forecasted impending disaster, heightened our sense of urgency and now offered us an exit strategy. The Paris Climate Agreement is a neatly constructed blueprint for crisis response, unbounded by former historical uncertainty and buttressed by multilateral cooperation. Although the process will take considerable time, developing countries like Morocco, Chile and Bangladesh are building a shared, farsighted perspective off of the Paris Agreement's momentum, setting the stage to finally decouple economic growth from fossil fuels and greenhouse gas emissions and inaugurate the essential arrival of a new development paradigm.

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