Renewable Energy in Peripheral Nations:

Rhetoric v. Reality

A thesis presented by

Kori Groenveld

to

The Lewis & Clark College Environmental Studies Program

In partial fulfillment for the degree of

Bachelor of Arts

With Honors in Environmental Studies

Lewis & Clark College

Portland, OR

May 2, 2018

Abstract

The Global North is increasingly investing in renewable energy projects in the Global South, advertised as a "win-win" sustainable project model that will both mitigate climate change efficiently and give Africa the energy it needs to economically develop. In investigating how sustainability projects reproduce the vices of the broader systems they arise from, I focus on the growing number of renewable energy projects in peripheral nations. I focus on Sub-Saharan Africa as a region that is unique in its economic development and growing focus on renewable energy. In addition to macroeconomic linear regression analysis, the two case studies I look at - the Grand Inga Dam in the Democratic Republic of the Congo and the Lake Turkana Wind Power Project in Kenya - illustrate how sustainability can serve as both a motivator for climate mitigation and guise for perpetuations of inequality on local, regional, and global scales.

Acknowledgements

I would like to thank the ENVS professors, Jim Proctor and Liz Safran, and Moriah Bostian for their continuous support in writing this thesis and throughout my academic career at Lewis & Clark College. I am also incredibly grateful to my housemates, friends, cross country team, and family for the emotional support that has helped me make it through four years at Lewis & Clark and complete this thesis.

Background

A Historic Crossroads

In the face of climate change, world leaders are facing major decisions regarding how to adapt an international political and economic system that is entrenched in emissions. Burning fossil fuels for energy is the conclusive driver of climate change and thus changing this process to a more sustainable system, while still maintaining and expanding the supply of energy available for industrial and personal use, is a critical step towards mitigating climate change (Kalicki and Goldwyn 2013). Similar to water, shelter, and food as intimately interconnected functional “sectors” of economic life, energy is key to the general development of society itself (Speth 2008). Electricity is a form of energy, rather than a source, and thus its widespread generation and use depends upon ecosystems to provide abundant low-cost fuel. The history of electricity expansion is, therefore, inherently an environmental history (Pasqualetti 2011). Currently residing at a historic “crossroads” of a global transformation away from carbon infrastructures, various agents are facing not only an intractable technical undertaking, but also monumental political and cultural challenges (Smil 2005). This is reflected in the greatest resurgence in the study of energy - where we source it from, who uses it, and at what cost - by political scientists, engineers, policy makers, scientists, social scientists, etc. since the oil crisis in the 1970s (Graaf et al. 2016).

Yet, despite this centrality of energy policy in mitigating climate change, “no other issue has proven so resistant to conceptual rigor and theoretical development” (Wilson 1987), a conclusion that scholars maintain is, unfortunately, “as valid today as it was in the late 1980s” (Graaf et al. 2016). The current “largely descriptive, atheoretical, and noncumulative” collection of research on energy is insufficient to address the policy salience, social pervasiveness, long-term nature, and sheer magnitude of the energy issues the world faces today (Wilson 1987). To contribute to the effort in addressing this academic gap, I attempt in this thesis to analyse a specific, yet growing type of energy projects: renewable energy in peripheral countries. Analysis of renewable energy projects can help shed light on how they affect other issues, such as poverty and wealth inequality, that see a renewable energy transformation as a window of opportunity through which the restructuring of the global energy infrastructure can restructure long-lived, large scale ‘socio-technical regimes’ (McEwan 2017).

Core country-financed investments in renewable energy, as a form of sustainable investment, are effective in climate change mitigation and macroeconomic development, yet, due to the projects roots in capitalist and neoliberal systems, are macro-economic drivers of inequality through creating a net flow of money for the Global North and failing to provide the equitable access to electricity necessary for sustainable development.

The Case for the Status Quo

The renewable energy transformation poses both challenges and opportunities for poverty and inequality. As economic growth in the US and other core countries slows down, wealthy investors are increasingly engaging in foreign investment in peripheral countries in order to obtain a better return on investment (Piketty 2014). This continues a trend started by the World Bank and other development organizations several decades ago. Economic development in historically marginalized regions first became a national priority in President Truman's "Four Point" speech in 1949, in which he called on the power and duty of the United States to help with "world economic recovery" from WWII through "a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas" (Packenham 2015). The Marshall Plan served as the first successful instance of "aid" - consisting of financial stimulus to be used under US instruction. The World Bank, the IMF, and later the WTO grew to serve as an institutionalized form of the Marshall Plan with the goals of both reducing poverty in the Global South and achieving the US's economic ambitions abroad (Steil 2013). These institutions helped what began as Reaganomics domestically in the 1980s be exported abroad to the Global South in the 1990s as neoliberalism. As promoted by classical economics, the IMF and the WB gave loans to developing nations with conditions known as "structural adjustment" measures, that essentially required developing nations to prime their markets for foreign investment, lower capital barriers, and cut social welfare programs in order to reduce government spending (Bornschier, Chase-Dunn, and Rubinson 1978). It was assumed that this would lead to convergence of rich and poor countries as well as eventual reduction of inequalities through the free flow of capital and the equalization of the marginal productivity of capital at the global level. Critics argue that this strategy, as exemplified by the nations throughout the perpetually "developing" world that have employed it, has not yet worked in achieving convergence, but has worked well in helping the US develop profitable economic resource investments and markets abroad (Mkandawire and Soludo 1999).

The growing trend of core-country led investment in renewable energy in peripheral nations serves as an avenue to study a form of supply-side economics termed "sustainable" (Showers 2009). Through investing in renewable energy, firms from the US and other core nations are able to meet their commitments to climate change while also driving top-down economic development through building the electricity infrastructure that Africa "desperately needs" (Africa Progress Panel 2015). In theory, this energy will fuel industrial development, which will contribute to macroeconomic growth that will eventually benefit all of the citizens of the country through tax revenue and job creation. In the rhetoric published by development funds, corporations, and other core-country investors, the Sustainable Development Goals (SDGs) set forward by the UN are often cited as highly important in making a renewable energy project "commercially viable" (Nørgaard 2017). These SDGs include ending poverty, fighting inequality and injustice, and tackling climate change by 2030.

Rhetoric has played an important role in development so far - as illustrated by the host of names for neoliberalism: "supply side economics", "reaganomics", "thatcherism", "classical economics", "trickle down economics", "liberalism" (Klamer, McCloskey, and Solow 1988). The different names serve to facilitate acceptance of the same economic policy in different contexts. While many of these terms are outdated, the role of rhetoric in facilitating endorsement of fiscal policy is not. "Sustainability", "the green economy", and "environmentally friendly" all serve to frame projects as inherently positive, futuristic, and effective (Shi 2004). In this thesis, I intend to examine how sustainability rhetoric is used to promote investment in projects while potentially obscuring their negative effects.

The Case (or need) for Something New

However, development projects can adversely affect economic development in peripheral regions as they continue age-old power dynamics and forms of economic extraction for the benefit of the global north (Harvey 2007). Contrary to classical economic theory, there is nothing to prevent core countries from owning their investments indefinitely and growing their share of ownership to massive proportions. Thus, the national income (or GDP) of wealthy countries can remain permanently greater than that of poor countries, which continue to pay foreigners a substantial share of what their citizens produce (Piketty 2014). Currently, net income from abroad is 2-3% of GDP in core countries, which is roughly equal to the flow out of other countries. In Africa, the income is roughly 5% less than the country's output (Piketty and Zucman 2014). Capital mobility and foreign investment are thus not necessarily primary factors in promoting the convergence of rich and poor nations.

World Systems Theory, as proposed by Immanuel Wallerstein, argues that the current global economic system will permanently prevent the convergence of rich and poor nations - as the wealth of the Global North depends on the extraction of resources and labor from the Global South (Wallerstein 1979). Foreign investment in the Global South, rather than an agent of economic development, disproportionately benefits the Global North through facilitating extraction. Several scholars in development economic counter this, arguing that development institutions and private companies investing in the Global South are effectively working towards "political and economic freedoms" that mutually compliment each other (Sen 2001). Through using traditional development models to expand the benefits of globalization, they aim to achieve economic development and poverty reduction through elimination of the restrictions of poverty.

Renewable energy is an increasingly attractive recipient for foreign investment, as illustrated by China's 60% increase in foreign investment in renewables last year (Jaeger 2007). While many have concerns regarding the effects economic development of peripheral countries will have on climate change, renewable energy minimizes these concerns through increasing electricity availability and dependability for economic growth while maintaining low emissions (Dincer 2000). In addition, it is cheaper for core countries to achieve their emissions targets by investing in renewable energy in peripheral countries rather than change their own energy infrastructure. At least for utility companies, which form a powerful lobby in the US, there is great motivation to reduce renewable energy growth in order to prevent being left with stranded assets (IRENA 2017).

In the case of the European Union Emissions Trading Scheme (ETS), there was a set number of carbon emissions allocated to each country under the Kyoto Protocol. Since the start of this program, most European nations have reduced their emissions in the most financially efficient ways, otherwise known as the "low-hanging fruit" (Ellerman and Buchner 2007). Now, further steps to reduce emissions domestically will be increasingly costly. An alternative to pursuing expensive reductions domestically is the “clean development mechanism”, in which European firms can finance clean energy or other forms of clean development in the developing world (Ellerman and Buchner 2007).

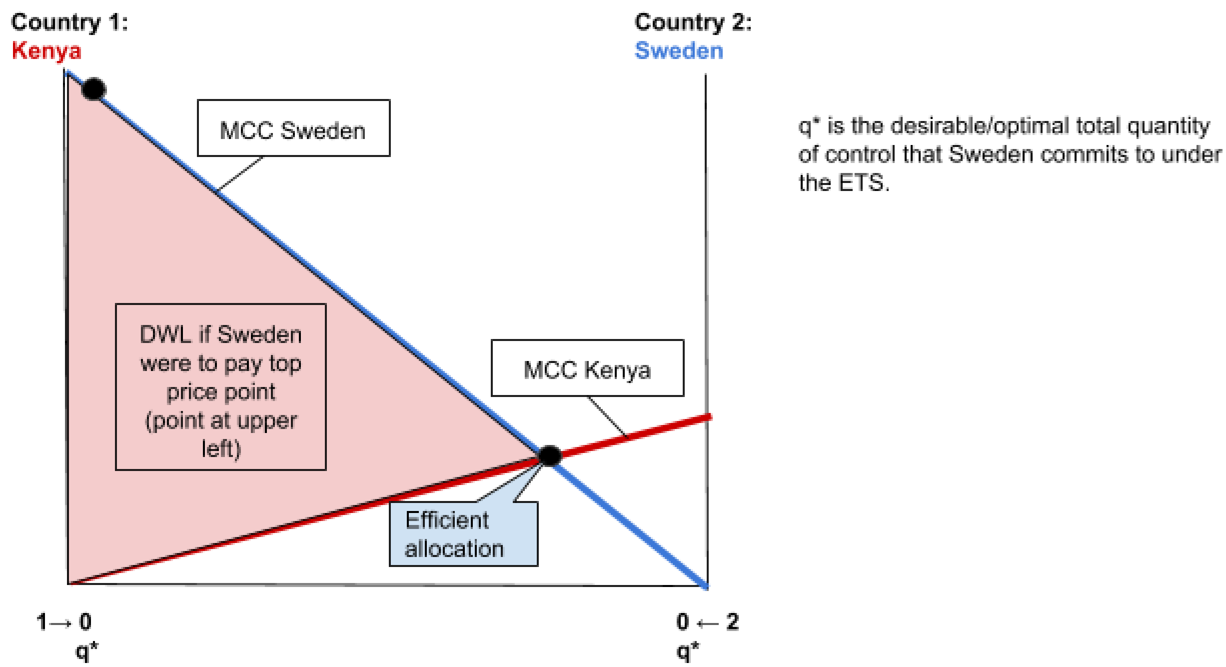

Figure 1

Figure 1 serves to model Sweden as an example. As illustrated, it is cheaper for Sweden to meet its emission reduction requirements by funding Clean Development Mechanisms (CDMs) in Kenya than it would be to pursue the same quantity of control domestically. In many regions in Sub-Saharan Africa, energy infrastructure is not yet in place. It is thus more efficient to build clean energy here than to retrofit the existing systems domestically. Furthermore, an increased consumer pressure on sustainability and corporate social responsibility in corporate behavior further incentivizes renewable energy investment as method of increasing consumer trust (Parkhurst 2017). The situation detailed in the graph above is increasingly common in European countries, as CDMs serve to increase efficiency in meeting ETS commitments while simultaneously enhancing the marketable sustainability profiles of firms (van Vuuren et al. 2017).

Essentially, as a solution to climate change, a driver of economic growth, an alternative to more costly infrastructure development in core countries, and an enhancement to consumer trust, renewable energy appears to be a “win-win” for all parties involved. However, aside from being touted as “sustainable” and “environmentally friendly”, investment in renewable energy is fundamentally not immune to the vices of foreign investment described above. This begs the question of if and how sustainability projects reproduce the vices, like wealth inequality and environmental destruction, of the economic systems they arise from.

I will now go through the global debate over energy sources, followed by how this debate is happening in Sub-Saharan Africa currently. Following this background information, I will go through my research methodology.

The Case for Renewable Energy Sources

Some see renewable sources as key to reducing this energy poverty, as it will help achieve many of the UN's Sustainable Development Goals (SDG), including ending poverty and hunger, improving health and education, combating climate change, and protecting forests (Transforming our World 2015). Energy on its own provides the basis for progress on a number of goals. Through enhancing agricultural productivity and food security as well as education quality and gender equality, it serves as a bottleneck for economic growth and poverty reduction.

Renewable energy, as opposed to fossil fuels, returns additional benefits to its host country. First, it promotes energy security through allowing the country to become independent from fuel imports, thus ensuring reliable and sustainable energy. Second, modern renewable energy technologies stand to reduce the indoor pollution caused by traditional energy sources, like coal and biomass (Torres-Duque, et al. 2008). This would improve the welfare of women, who disproportionately deal with this burden (Dinkelman 2011) and promote sustainable use of ecosystems through replacing the need to collect firewood (Odihi 2003).

Third, renewable energy generates much less CO2 than fossil fuels and thus hardly accelerates climate change. This has the long term prospect of having the most influence on the other SDG. Africa is at the highest risk to the impacts of climate change, which may make any unsustainably achieved progress on the SDG short-lived (Schwerhoff and Sy 2017). For example, a projected increase in droughts across the continent will not only damage agricultural activities as they relate to food security, but also to economic growth on a continent heavily relying on agriculture (IPCC 2014).

The Case for Fossil Fuels

The current investment trends favor fossil fuels. While renewable energy facilities are typically expensive to set up and inexpensive to maintain, fossil fuels are typically inexpensive to set up but expensive to maintain. Governments, normally the primary investors in energy generation, can borrow at the market only at high cost, which causes them to favor investments low up-front cost investments in fossil fuel based electricity generation (Steffen, et al. 2017). Furthermore, the social benefits far outweigh the private benefits for investors in renewable energy projects. It is thus easier for governments to attract investors to those of fossil fuels, as the proportional private return on investment is greater. However, in interviews that the UNDP conducted with investors in renewable energy, governance related risks (complex bureaucracy, changing regulation, corruption, low political stability) were cited as the largest barriers to investment (Komendantova, et al. 2012).

Renewable Energy, Economic Development, and Inequality: A Mixed Report Card

The debate regarding the relationship between energy consumption and economic growth continues to attract a vast empirical and theoretical literature, mostly proposing four perspectives on the causal relationships at work:

1. Economic growth causes energy consumption. Essentially, different growing sectors of the economy demand more energy (Odhiambo 2016).

2. Energy consumption causes economic growth.

3. There is bi-directional causality between electricity and economic growth, they cause each other.

4. There is no causal relationship between energy consumption and economic growth. They are neutral in respect to each other.

A number of studies have focused on this causal relationship through cross-sectional data, which does not satisfactorily address country-specific issues. By grouping countries that are at different stages of economic development, the studies can obscure important heterogeneous characteristics that can create different causalties in different countries, thus driving inconsistent and misleading estimates (see Ghirmay 2004; Quah 1993; Casselli et al., 1996; Odhiambo 2008 & 2009). Even with time-series data, the empirical findings on the relationship between energy consumption and economic growth have been largely inconclusive (Odhiambo 2009). The current study, therefore, attempts to give an overview of the relationship between renewable energy consumption and economic growth and inequality, supplemented with two in depth case studies in order to satisfactorily address country specific issues.

Situated Context | Key Actors/Processes

Focus Question

How has inequality accompanied renewable energy development in Sub-Saharan Africa and what light can specific projects shed on causal relationships between these factors?

A unique place to study renewable energy and its relationship to economic development and inequality is Sub-Saharan Africa. In this section I will give a background of the political and economic reasons for this unique place of study, as well as the current energy mix and outlook for the region.

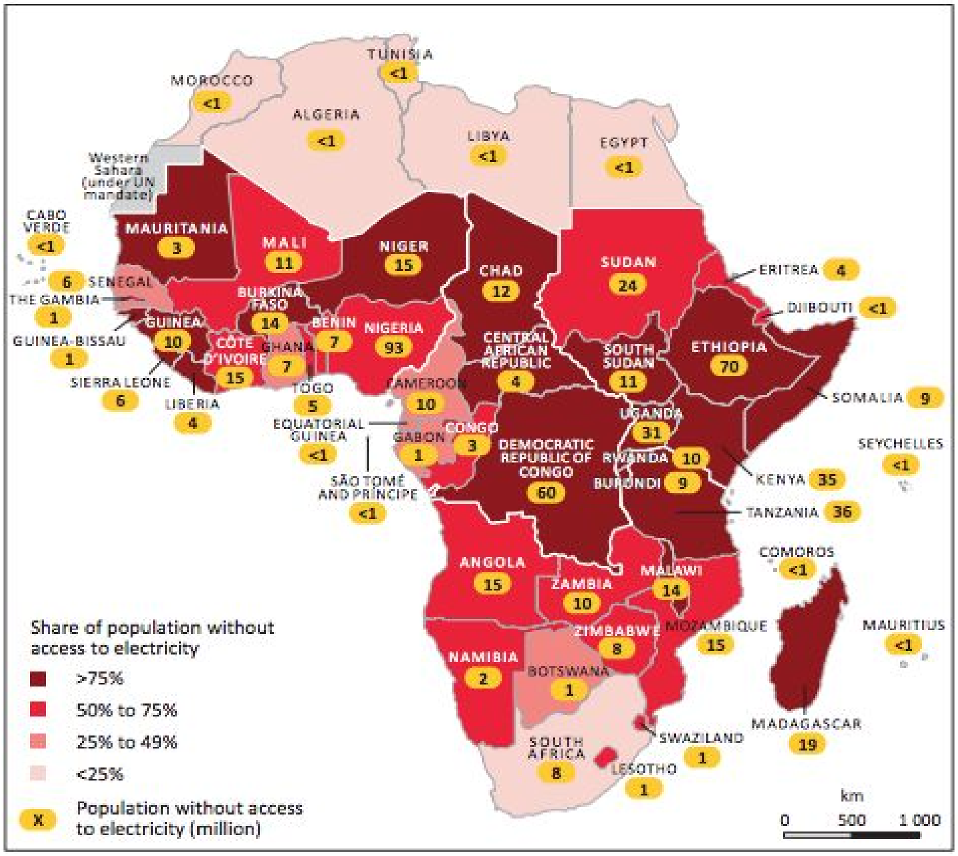

Figure 2: *Number and share of people without access to electricity by country, 2012 (Chibambo 2017)*

A Brief Picture of the Current Energy Supply in Sub-Saharan Africa (SSA)

Sub-Saharan Africa has more people living without access to electricity than any other major world region - nearly half of the global total with more than 620 million people. Simultaneously, the African continent has the highest technical potential (about 983 EJ) for wind, solar, and biomass energy of anywhere in the world (de Vries, van Vuuren, and Hoogwijk 2007). While it is the only region where the number of people living without people is increasing, as population growth continues to outpace efforts to expand access, there are still countries like Nigeria, Ethiopia, South Africa, Ghana, Cameroon, and Mozambique which are working to combat this and have expanded electricity access to 145 million people since 2000 (Winkler et al. 2017). It is in the midst of these paradoxes that I hope to answer questions about renewable energy and its role in the fabric of Sub-Saharan Africa's development.

About 80% of the people lacking access to electricity in Sub-Saharan Africa live in rural areas. While urbanization has historically helped expand electricity access in developing regions, this will not have the same effect in this region as both urban and rural regions are projected to see significant growth. Thus, appropriate energy strategies and technical solutions will have to target rural, urban, and peri-urban communities (*Global Report on Human Settlements* 2013).

The existing energy resources in Sub-Saharan Africa are more than enough to meet regional needs for now and into the foreseeable future. While the region has sufficient oil, coal, and gas for more than 100, 400, and 600 years respectively, there is also an abundance of high quality renewable sources, including hydro, wind, solar, and geothermal. These are currently at different stages of development and spread unevenly across the continent, but it is likely that the resources available will increase as exploration and assessment continue. There is immense opportunity at present to create a modern energy sector that draws across these varied resources, but "the path from theoretical potential to harnessed supply is likely to be long and complicated" (IEA 2017).

The International Energy Agency predicts that demand for electricity will grow by 80% by 2040 (Graaf et al. 2016). Unless significant incentives are put in place, fossil fuels will likely meet the majority of this growing demand over the next decades. In facing the decision between these two types of energy sources, researchers and international climate policy makers are increasingly interested in supporting the development of low-carbon energy systems where efforts to "address energy poverty can also be those that would set countries on the much sought-alternative path to low-carbon development" (Kabo-Bah and Diji 2018). This rhetoric is part of a discourse promoting "climate-compatible development", in which renewable energy systems deliver a "win-win" scenario of poverty alleviation, climate adaptation, and climate mitigation (Lotz-Sisitka and Urquhart 2014). The discord between this rhetoric, mirrored in the Paris Climate Agreement which echoes "the need to promote universal access to sustainable energy in developing countries, in particular in Africa, through the enhanced deployment of renewable energy (Clémençon 2016), and the growing interest in Africa's fossil fuel resources paints an uncertain future for Africa's energy supply.

Key Actors

There are a host of important actors and stakeholders working to meet the growing energy demand in SSA, while also navigating the dual pressures of climate change mitigation and efficient economic development. While national governments, development finance institutions, and international companies are typically the most prominent actors in renewable energy projects in Sub-Saharan Africa, there are many other actors impacted by these projects: the people living in the areas surrounding the projects, which face an influx of construction work and a temporary service economy, areas that receive electricity from the projects, which benefit from a higher capacity, more reliable grid, and rural citizens that likely will not receive electricity from the projects but will pay taxes to fund government debt incurred in financing the projects. The actors that drive these projects and largely determine these effects on surrounding populations follow a top-down model that combines both state and private actors (Flyvbjerg 2017).

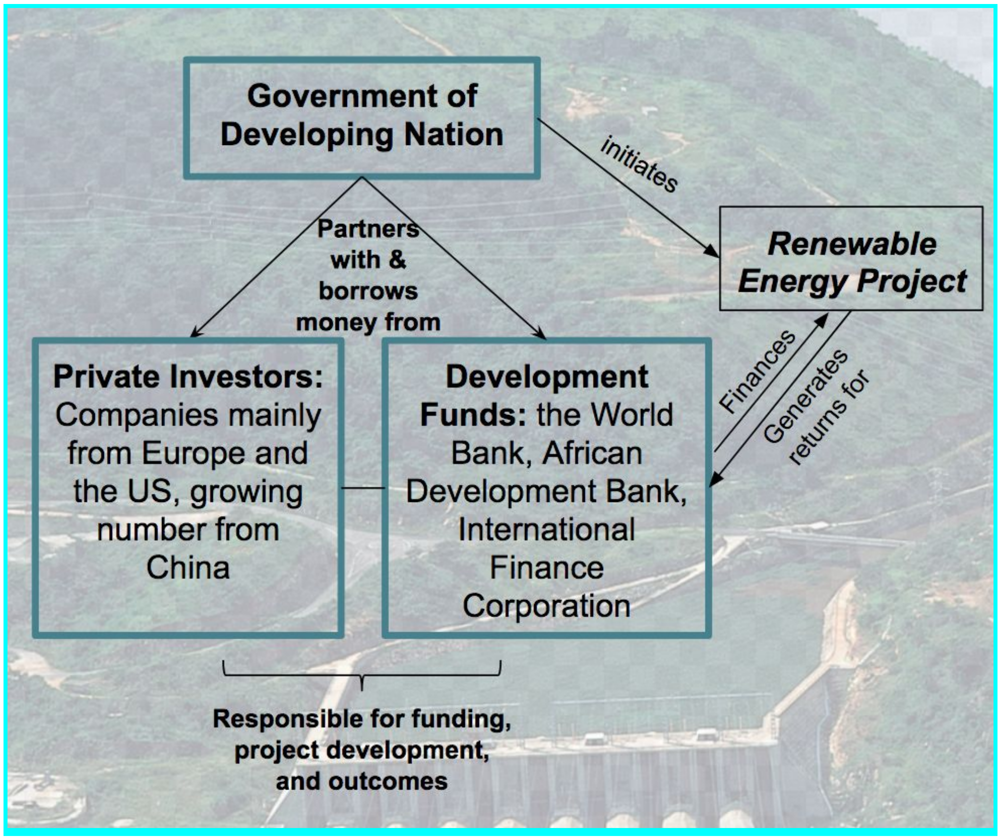

Figure 4

The implementation of modern renewable energy in Sub-Saharan Africa has been primarily driven by national governments using top-down policy instruments focused on financial incentives (Winkler, et al. 2017). Governments propose a project and then host a type of bidding consortium, attracting investors through investment subsidies, tax exemptions, emission regulations, feed-in tariffs, and provision of venture capital to support market introduction of renewable energy technology (Negro, Alkemade, and Hekkert 2012). Unfortunately, the lack of stable and sufficiently aligned regional and local institutions create systemic problems in RE project implementation in Sub-Saharan Africa. Delayed issuing of power purchase agreements, conflicting messages from different government entities, and insecurity about energy tariffs create unstable policy support and constitute a major barrier for expanding electricity access (Haselip et al. 2011). Development finance institutions and private companies constitute the largest investors in these projects, but the coordination among policies and institutions necessary for successful implementation is largely up to the national governments (Msimanga and Sebitosi 2014). I will look at two projects - one financed by a development finance organization and one primarily financed by a private company - in order to shed more light on these two dominant project models.

Funding Source	IBRD and IDA	Other	IBRD and IDA	Other
	2009-2014		**2014**	
RE and Electricity	11,567.10	65.16	2080.84	13.50
Oil & Gas	1,936.66	5.38	1,936.66	0.85

Figure 5: Funding approved (million USD) for the energy sector in Africa by the WB **(**World Bank and Schwerhoff & Sy 2017). IBRD: International Bank for Reconstruction and Development, IDA: International Development Association

In hosting a bidding consortium to fund projects, development finance institutions are often key bidders and supporters. The World Bank lends directly for climate change mitigation and manages the Climate Investment Funds, the Strategic Climate Fund, and the Carbon Partnership Facility for this purpose. Figure 5 illustrates how the World Bank funds energy projects in Africa. The World Bank (WB) has been a key financier of development projects in Africa for decades. Among its top seven priority areas of strategic focus are affordable and reliable energy and climate change. Using a project-based lending approach, the World Bank administers funding to these ends through the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), the climate funds mentioned above, and the International Finance Corporation (IFC). Beginning in the 1980s, the WB began a broad effort to socio-politically engineer governance in the states of post-colonial Africa (Harrison 2004). This neoliberal reform - named structural adjustment - generated destabilizing effects on Sub-Saharan African societies. This instability has created a disheartening success rate in the Bank's projects. As of 2002, only 36% of the World Bank financed electric power projects were successful (Dunmade 2002).

The African Development Bank also supplies significant investment in renewable energy through contributing $625 million annually to the Climate Investment Fund and establishing the Sustainable Energy Fund for Africa, which is co-financed by the governments of the US and Denmark with about $60 million annually (Gujba et al. 2012). Considerable financial and technical backup also comes from international companies. These companies are contributing to the slow shift away from mega-multilateralism in financing electricity generation projects, as non-typical actors such as cities, corporations, civic society organizations, and regional governments are being heralded as key to achieving climate policy goals (Newell and Bulkeley 2017).

The Case for Renewable Energy Sources in SSA

In meeting the energy gap in SSA, renewable energy is one solution that private and state actors are considering. Currently, bioenergy is the dominant source of energy in the Sub-Saharan mix, mainly derived from solid biomass in the residential sector. This comes from the roughly one third of Sub-Saharan Africa covered by forest, estimated to makeup a biomass stock of 130 billion tons in 2010, and primarily fuels Central Africa and parts of Southern Africa. Agricultural products and residues also constitute the biomass resources available and primarily fuel East and West Africa (IEA 2017). As this region looks to expand electricity supply, these available resources can grow to constitute a significant share of the mix. In Cameroon, for example, sustainable extracted forestry and agricultural residues can supply close to 40% of the country's electricity production (Ackom et al. 2013).

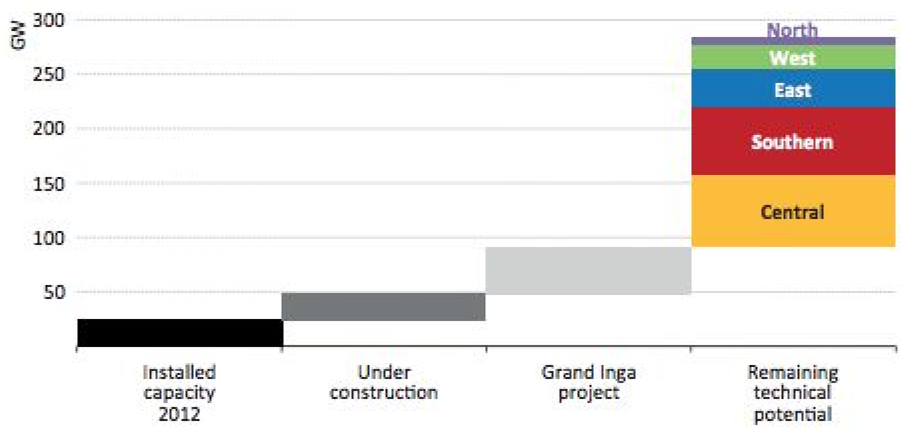

Figure 3: Existing Hydropower Capacity and Potential in Africa

Sources: IPCC (2011); IJHD (2009) and (2010); IEA analysis.

Hydropower is the second largest source of energy for the region and has the potential to generate more than three times the current electricity consumption in Sub-Saharan Africa (IEA 2017). Attractive due to large-scale potential deployment costs and having the lowest average costs of electricity generation technology (renewable or otherwise), policy makers are focused on increasing exploitation of this source (IEA 2017). As I will focus on in one of my case studies below, investors are particularly interested in the large hydropower potential of the DR Congo. Both the Inga III and the Grand Inga projects, if constructed, stand to transform the power supply picture in Africa. I will go over barriers to the economic exploitation of hydropower in the case study below.

Solar, wind, and geothermal have so far played a limited role in the power sector in Africa, but are gaining attention as increased surveys and analysis reveal its economic potential. Private companies are increasingly investing in these forms of energy, as their alternative return on investment, through boost to corporate social responsibility and carbon credits, makes them more attractive over fossil fuel projects.

The Case for Fossil Fuels in SSA & the Moral Debate Over Climate Change

As an alternative to renewable energy sources, oil and natural gas currently do not make up a large part of the energy supply, but this is likely to change in the future. Sub-Saharan Africa accounted for 30% of global oil and gas discoveries in the past five years and the USGS estimates that there are billions of barrels yet to be discovered (IEA 2017). However, the majority of Sub-Saharan Africa has exported 85% of its oil, which leaves little to go to the citizens of the countries sourcing the energy. There is potential for this to happen with large scale renewable energy projects as well, as I will examine in two case studies.

To balance the attraction of fossil fuels, climate change mitigation also presents important considerations. A historic argument used to argue for fossil fuels in Africa is that since emissions created by economic development in the Global North is largely responsible for climate change, Africa should not have to slow its economic growth down with more expensive, less efficient renewable sources in order to mitigate a phenomena it did not create. In the early days of international climate policy, this argument was relatively straightforward and helped in dividing responsibility among those countries that contributed to modern levels of GHG emissions and those that did not. However, the line of division has become blurred as economic development and the changing nature of production and consumption have fundamentally reshaped this landscape (Newell and Bulkeley 2017).

Various illustrations of growth indicate that Africa has an increasing role for global mitigation efforts. The World Economic Outlook of the International Monetary Fund has stated that GDP growth will continue to be above 5.5% for several years to come in Sub-Saharan Africa (Mberu and Ezeh 2017) and according to shared socioeconomic pathways (SSPs), GDP in the region will grow at an average annual rate of 3.5% until 2100, which would approach the development level of the US today. Furthermore, the United Nations Population Fund (UNFPA) predicts the working age population in the region to increase by 150% by 2050 (Erken, Mateo Diaz, and Engelman 2017). Given the emissions that will accompany this economic and population growth, Sub-Saharan Africa has a high level control over the degree of climate impacts it will face.

Kenya

Kenya is currently navigating the private-public funding model in constructing the Lake Turkana Wind Power Project. To give a brief description of Kenya's historical and geographical context, the country is located on the equator and the east coast of Africa, sharing borders with Somalia on the east, Ethiopia to the north, South Sudan to the northwest, Uganda directly to the west, and Tanzania to the south (Figure 6). Most of Kenya has a tropical climate, but there are desert regions in the north and northeast parts of the country. The highlands, divided by the Great Rift Valley, are cool and agriculturally rich. Major cash crops, including tea, pyrethrum, wheat, corn,and coffee, are managed by both large and small farms. In the north, where the Lake

Turkana project I will be focusing on is located, pastoralism is the main land use. Led by President Uhuru Kenyatta, the country's ethnic diversity across these various ecological and economic regions has also proven a source of conflict. As a regional hub for communication, trade, finance, and transportation and one of the largest economies in the East African Community, Kenya has established itself as an economic powerhouse in the region (Owino et al. 2016). In light of the issues of high unemployment, crime, poverty, and an increase in Islamic militant movements, the country is pursuing economic growth as a solution. Climate change will exacerbate tightly woven social, political, and economic instability, as population is expected to double within the country in the next decades and urbanization increases. Prohibitively high costs, irregular supply, and poorly maintained infrastructure has created low access to modern electricity. All of these issues incentivize Kenya to pursue geen economic growth.

There are three main sources of energy in Kenya: 74.6% biomass, petroleum 19.1%, and electricity 5.9%. As in many developing countries, non commercial biomass supplies energy primarily to the domestic and residential sectors. Transportation, agriculture, and commercial and industrial sectors primarily rely on petroleum fuels and electricity.

Figure 5: Kiplagat, Wang, and Li 2011

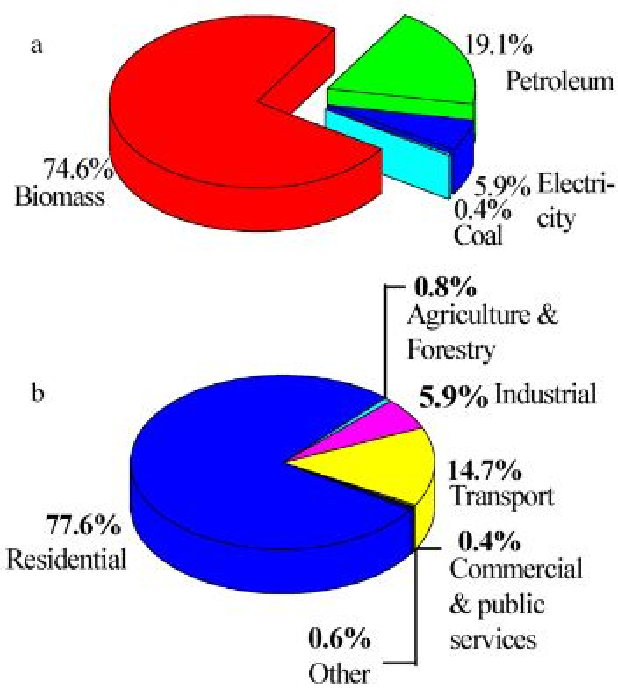

Fig. 1. (a) Energy supply in Kenya by type. (b) Energy consumption by sector [4].

Figure 6: Map - Google Maps

Figure 7: ***Google Maps***

The total installed electric power generation capacity, as the main source of modern energy for the country, supplies 1345 MW of energy composed of hydropower, oil thermal, geothermal, and cogeneration from sugercane baggase and wind generation. Renewable energy contributes 80% of the national grid's energy, which makes Kenya's electricity among the most sustainable in the world (Kiplagat, Wang, and Li 2011) .Electricity is distributed through four main interconnected grids and 11 additional isolated power stations, with the government currently developing four more. The power industry is organized according to the oversight bodies (the Ministry of Energy, Energy Regulatory Commission, and the Rural Electrification Authority), the energy producers (the Kenya Electricity Generating

Company is the primary power generator in the country and accounts for 75% of installed capacity), and the transmission and distribution companies (Kiplagat, Wang, and Li 2011). The Ministry of Energy is the primary policy director, prepares least cost energy development plans, and facilitates investment and mobilization of resources for power development. The Renewable Energy Department runs 10 energy centers in major ecological zones, in which information regarding implemented biofuels, solar, wind, mini/micro hydropower, and energy conservation is disseminated to, and feedback is received from the public (Kiplagat, Wang, and

Li 2011). The Rural Electrification Program works to accelerate implementation of projects lined up for transmission extension throughout the country (Harries 2002).

Surging demand for power, the rising cost of oil, the need to address global warming, and the effect of concurrent drought on hydropower has increased interest in wind energy in Kenya. The Lake Turkana project, which I will focus on, is the biggest wind power project ever in Kenya and one of the largest wind farms in Africa, with a capacity of 300MW. As renewable sources like wind power become more popular in Kenya and throughout Sub-Saharan Africa, I hope to investigate this project and how it has directly affected inequality and economic development in Kenya.

The Democratic Republic of Congo (DRC)

Although in the same region as Kenya, the DRC has a much more complicated and violent recent history. The Democratic Republic of Congo in the largest country of Francophone Africa, spanning a surface area of 2.3 million square kilometers with vast natural resources. With about 60% of the country living in rural areas, the country has approximately 80 million hectares of arable land and over 1,100 minerals and precious metals.

The DRC has a complicated and violent history that continues to influence the present in both clear and complicated ways. Resource exploitation on an industrial scale began in its early colonial history, when King Leopold II of Belgium nearly satisfied global demand for rubber to manufacture automobiles with exports from the colony, and continues today, when the DRC accounts for nearly 55% of the production of coltan, which is a key component of cell phones (Ridder et al. 2013). Recently at the center of what was called “Africa’s world war”, the country’s vast mineral wealth provoked multiple conflicts in the 1990s (“Overview: The Democratic Republic of Congo” 2017). The DRC’s mineral wealth, composed of diamond, gold, and uranium deposits, have attracted the strategic attention of foreign governments and multinational corporations.

Fighting broke out on multiple sides in attempts to take advantage of anarchy to plunder natural resources. Militia continue to fight in the eastern region of the country, where UN PeaceKeepers are trying to maintain peace. This ongoing conflict has had deep economic and social consequences. Apart from a slight decrease in poverty rate from 2005 to 2012, from 71% to 64%, the DRC ranks among the poorest countries in the world at position 176 out of 187 (UNDP 2015). Democratic elections, originally planned for 2016, have been postponed until December 2018 due to an outdated electoral register. These elections are necessary to creating the political force necessary to address the estimated 2.3 million displaced persons and refugees within the country as well as the 323,000 DRC nationals living in refugee camps outside of the country (UNDP 2015). If the country is able to overcome its political instability, it can become one of the richest countries on the African continent and a driver of African growth.

The DRC has among the lowest electrification rates in the world (“Power Africa in Democratic Republic of the Congo | Power Africa | U.S. Agency for International Development” 2018). Based on 2013 data, the national electrification access rate is 9%, with 19% in urban areas and

1% in rural areas (Gottschalk 2016). Most available power has gone to the rapidly growing mining sector, which is focused in the copper belt. New mine development has been frozen until more power becomes available, which, compounded with a current shortfall of 300MW in the copper sector, presents a large handicap for the economic growth necessary to resolve the country's social and political issues .

99% of the DRC's 2,500MW installed generation capacity comes from hydropower, of which most comes from the Inga site (1,775MW). The government is currently attempting to expand the Inga 3 project, as I will focus more on in my case study below, to reach 5,000MW (Africa, Lighting. "Lighting Africa Policy Report Note–Cameroon." *IFC and WB* 2012). The DRC currently uses just 2% of its estimated 100,000 MW of hydroelectric power potential, mostly due to four main barriers that are true for most of Sub-Saharan Africa. First, like other sources of renewable energy, hydropower requires large sums of upfront capital and for power purchase agreements to already be in place to raise the necessary financing. Second, a lack of a widespread domestic or international grid makes it difficult to export large volumes of electricity. Third, seasonal and annual variations in river discharge can make baseload power generation unreliable. Fourth, environmental and social concerns require in depth public consultation, as hydropower dams may require flooding large land areas, potentially displacing communities and reducing the flow of water available for other uses downstream, such as agriculture. In addition, a lack of required technical expertise slows down hydropower development in some countries.

I intend to further explore the potential for hydropower and how it affects inequality and development through the Grand Inga Hydropower Project case study I will elaborate on below.

Methodology

I will investigate how inequality has accompanied renewable energy development in Sub-Saharan Africa through analysing change in renewable energy consumption over time in the region as it relates to indicators of inequality - poverty headcount ratio, external debt stock - and development - GDP, gender parity in schools. I will use linear regressions to look into the relationship between renewable energy and various measures of economic development and inequality from 1990-2012. I will summarize the statistical analysis below, with the full data attached in Appendix 1. In each regression, I will compare renewable energy consumption over time to another development indicator over the same time period. To assess renewable energy, I will use the World Bank indicator of renewable energy consumption (% of total final energy consumption). This weighted average of data collected from the World Bank, the International Energy Agency, and the Energy Sector Management Assistance Program measures the share of renewable energy in total final energy consumption. This indicator includes energy consumption from all resources that the World Bank considers to be renewable: hydro, solid biofuels, wind, solar, liquid biofuels, biogas, geothermal, marine, and waste ("World Development Indicators" 2012).

In order to capture some of the specific elements not captured in the macroeconomic picture, I will look at two renewable energy projects in the region that represent the spectrum of projects currently at work in the developing world. The first case study - which investigates the Grand Inga Dam in the DRC - focuses on a model in which the primary funders are development funds that portray their investment as a form of aid. The second case study - which investigates the Lake Turkana Wind Power Project in Kenya - focuses on a newer but increasingly common model in which the primary funders are a coalition of private companies and development funds that portray their investment as a form of social responsibility and investment in a green economy. Through analyzing these projects through the lens of triple bottom line sustainability, I intend to illuminate a more direct relationship between the indicators above.

Procedure

I first conducted a statistical inquiry into the relationship between renewable energy and development in Sub-Saharan Africa. I used linear regression analysis to look at how changes in the x variable (renewable energy consumption) accompanied changes in different y variables (development indicators) from 1990-2014. I used World Bank data, as it provided the most consistent and comprehensive data on the nations in Sub-Saharan Africa. The specifics of the model I used are described below.

I then compiled two case studies on the Grand Inga Dam in the Democratic Republic of the Congo and the Lake Turkana Wind Power Project. In both cases, I first looked at the broader developmental and historical contexts of the countries, then focused in on how these projects fit within the broader developmental trends at work. I then went through the social, economic, and ecological elements of each project and how the reality of these elements creates different effects for different stakeholders. To further examine these results, I compared the projects to each other and contextualized them within the wider trend of foreign direct investment in peripheral nations.

Statistics Results and Discussion

Studies looking into how renewable energy has affected economic development and inequality have found mixed results (Neumayer 2001). Using World Bank data indicators for the region of South Africa, I investigate how changes in renewable energy consumption have accompanied changes in gender parity in education, external debt stocks, poverty rates, and GDP per capita. Through examining how different indicators of human and economic development have changed with renewable energy, I intend to clarify how renewable operates in tandem with economic and human development in the region of Sub-Saharan Africa.

This data covers 24 years, from 1990-2014. With so few data, it is hard to establish causality. It is also difficult to isolate other important variables, like governance for example, in the regressions. I will therefore postulate several ideas that have been proposed in the literature to explain the relationships.

The null hypothesis is that there is no significant linear relationship between the independent variable X and the dependent variable Y. The alternative hypothesis is that there is a relationship between the two variables. I have added time as an added explanatory factor, in order to isolate this variable in the relationships.

$y = \beta 0 + B1x + \mu$ y = dependent variable B0 = intercept B1x=Renewable Energy Consumption, %

Expectations From the Literature

Model 1: This measure assesses the total amount of debt owed to creditors outside of the country to gross national income. Debt ratios are used to assess the financial sustainability of a country's debt service obligations, however there are no absolute notions of what is too high. In Argentina, renewable energy has been positively associated with external debt (Ferreyra and Brown 2007), while in Lebanon renewable energy was shown to have a mixed impact on external debt.

Description of Data

Mean	49.59
Standard Deviation	20.82
Minimum Value	22.05
Maximum Value	81.41
Description of Data Value	A percentage of GNI, 0-100

Model 2: GDP per capita is gross domestic product divided by midyear population. This is a common measurement of macroeconomic growth. While some argue that renewable energy positively impacts economic growth (Ghirmay 2004), others argue that renewable energy is less efficient than fossil fuels in driving economic growth (Senker 2011).

Description of Data

Mean	911.20
Standard Deviation	473.66
Minimum Value	496.89
Maximum Value	1819.46
Description of Data Value	Average of per capita GDP for region

Model 3: Poverty headcount ratio at $1.90 a day is the percentage of the population living on less than $1.90 a day at 2011 international prices. This is a key variable in assessing the success of economic development, as it captures how effectively macroeconomic growth trickles down to reducing extreme poverty. Several studies illustrate the complicated relationship between renewable energy and poverty rate (Pedroni 2001, Sovacool and Walter 2018).

Description of Data

Mean	53.33
Standard Deviation	5.55
Minimum Value	44.20
Maximum Value	59.00
Description of Data Value	A percentage of the population, 0-100

Model 4: The Gender Parity Index for gross enrollment ratio in primary and secondary education is the ratio of girls to boys enrolled at primary and secondary levels in public and private schools. Eliminating gender disparities in education helps increase the status and capabilities of women, which is key to sustainable development. Renewable energy, through reducing the time and effort involved in household chores, alleviating the health risks associated with current energy practices, and reducing the female responsibility of collecting and managing biomass and fuel wood, can potentially serve to allow more women and girls to attend school (Habtezion 2013). This is a key step towards women entering the workforce, which in turn is key in driving long term economic growth.

Description of Data

Mean	0.96
Standard Deviation	0.04
Minimum Value	0.87
Maximum Value	0.99
Description of Data Value	Index 0-1

Model 1

External Debt	*Coefficients*	*P-value*
Intercept	-583.867	0.001
Ren. Energy	9.087	0.000
Time	-1.502	0.000
R Square	0.874	

Model 2

GDP per capita	*Coefficients*	*P-value*
Intercept	11801.807	0.013
Ren. Energy	-158.616	0.014
Time	39.034	0.000
R Square	0.822	

Model 3

Poverty Rate	*Coefficients*	*P-value*
Intercept	-179.221	0.036
Ren. Energy	3.290	0.012
Time	-0.394	0.020
R Square	0.924	

Model 4

GPI	*Coefficients*	*P-value*
Intercept	1.040	0.000
Ren. Energy	-0.003	0.184
Time	0.003	0.000
R Square	0.939	

Discussion

In the social sciences, any R Square above .5 is considered significant. Aside from Model 4, low p values indicate that each R Square is highly significant as related ot renewable energy consumption. There is strong evidence against $H0 : \beta = 0$. There is strong evidence in favor of $Hs : \beta \neq 0$. I will go through each indicator and postulate potential reasons for these relationships.

Model 1: The coefficient for external debt is positive, indicating that a 1% increase in renewable energy consumption accompanies a 9.1% increase in external debt. This strong relationship is likely due to nations paying for renewable energy projects, like Inga I and II, through loans to international development funds and corporations (Starr 1991).

Model 2: The coefficient for GDP is negative, indicating that a 1% increase in renewable energy consumption accompanies a $158 decrease in GDP per capita. This illustrates that the region of Sub-Saharan Africa differs from the portion of research that shows how renewable energy can positively impact economic growth (Ghirmay 2004, Senker 2011).

Model 3: The coefficient for poverty rate is positive, indicating that a 1% increase in renewable energy consumption accompanies a 3% increase in the percentage of the population living at or below $1.90 a day. There are several potential reasons for this relationship in Sub-Saharan Africa. First, renewable energy projects target populations that are living below this poverty line and need the energy the most. Second, renewable energy econompasses biomass. In the event of economic downturn in which more people are living on less than $1.90 a day, more people could turn to using biomass rather than more-expensive, fossil fuel-based electricity as energy. Third, renewable energy could drive inequality. While simultaneously driving macroeconomic growth, as seen in the GDP section above, the income from this products making up this measure could be going to foreign owners. This could come at the cost economic development within the lower classes and increase the number of people living at less than $1.90 a day.

Model 4: The coefficient for Gender Parity Index is nearly zero, indicating that a 1% increase in renewable energy accompanies no change in gender parity in education. However, the significance for this is above .05, indicating that this is not significant and that changes in renewable energy consumption do not have a clear relationship with changes in gender parity in education.

Similar to the results of other studies looking into the macroeconomic effects of renewable energy in the developing world, this brief comparison of renewable energy and other development indicators has yielded mixed results. While negatively associated with GDP, external debt stock, and poverty headcount - factors indicative of both inequality and economic instability- renewable energy is loosely related to gender parity in education - a factor generally indicative of positive human development. This indicates that the relationship between renewable energy and indicators of development and inequality is complicated. In order to gain more insight into the specific causal mechanisms behind these numbers, I will look at two case studies that represent two common models of renewable energy development in the region.

Case Study 1: The Grand Inga Dam III

This case study, in addition to the second one below, serves to investigate specific causal relationships that I could not capture in the linear regressions above. I will outline the history of the project so far and then work through how the project engages with triple-bottom line sustainability. In May 2013, the Democratic Republic of the Congo announced that it would begin construction on the world's largest hydroelectric project in history. This U.S.$80 billion project, funded as a public-private partnership, has promised to "light up Africa" through expanding electricity distribution to the millions of Africans that currently lack access. However, allegations of corruption, immense financial costs and controversial feasibility have put into question the project's intention to benefit the Congolese people. These various critiques, centered around excessive environmental and social costs, have driven decades of false starts. Most recently, the World Bank pulled out funding for the project only to replace this funding using the IFC, their private funding arm, which will allow the project to continue with less scrutiny than World Bank projects do ("World Bank Pulls Funding for Congo's Inga-3 Hydropower Project" 2016).

This project presents real risks to the citizens and the environment of the DRC, but simultaneously promises to provide the energy necessary to kickstart Africa's economic development. Regularly compared to other large renewable energy projects like the Three Gorges Dam in China, the Grand Inga constitutes a modern development project from which one can investigate the underlying causal mechanisms and impacts that drive "development" as an industry. As Chinese firms and other development organizations increasingly invest in hydropower and other "mega" energy projects, the Grand Inga is a project model that can shed light on important dynamics at work throughout the developing world (Venage 2017). Since mega projects can use the funding and resources equivalent to hundreds of smaller projects, they are worthy of special scrutiny in ensuring commensurate return on investment for all. The case study serves to analyze the Grand Inga as a sustainability project and how it affects economic development and inequality (Brunn 2011).

Project Background & Current Status

Imagined in 1885, studied in the 1920s, and officially endorsed and planned in the 1950s, the Grand Inga presents a saga of project evolution that has been integral to conversations over development and the future of Africa. The project site lies 93 miles upriver from the Congo's mouth into the Atlantic Ocean. This river is the second longest in the world (4,700 km/2,920 mi) after the Nile and the world's second largest by flow (42,000 m2/s, 1,483,230ft3/s) after the Amazon. This description, found as the primary descriptor in any text regarding the river, illustrates how the river's primary identity is physical and defined by flow measurements, instead of its former ecological identity. In 1921, the US Geological Survey assessed the African continent as having half of the world's hydroelectric potential, with the Congo having half of this portion (Kitson 1925). The river's significant rapids and waterfalls close to its mouth make it unique among the world's rivers in terms of its hydroelectric potential.

The project consists of three primary components (refer to figure X for visualization):

1. **The rehabilitation of existing Inga I and II dams (Figure 8):** The World Bank started rehabilitation in 2003 with an estimated cost of 200 million USD, with the intention of generating 40 million USD annually. The project has taken over a decade and has cost nearly 4 times this initial estimate at 883 million USD (Sanyanga 2013).

2. **The construction of Inga III:** Three international companies (China Three Gorges Corporation, Daewoo-Posco-Snc-Lavalin, and ACSEurofinsa) have been chosen to build and manage this dam over the next 5-10 years. With a price tag of 12-37 billion USD, this dam is considered a trial for stakeholders, the success or failure of which will determine the viability of the Grand Inga (Vidal 2013).

3. **The construction of several additional dams**, collectively known as the Grand Inga (Dams 4-8 in Figure 8).

The Grand Inga, comprised of a series of dams, stands to produce 40,000 MW of electricity, which is more than a third of the total electricity currently produced in Africa. To many, this dam is constitutes the solution to Africa's energy woes. AECOM and Electrite de France jointly conducted a feasibility report from 2011 to 2013, which describes the Inga's construction in two steps, with a low head and then a high head, extending the dam wall and making it higher ("Aecom, EDF Partner for Grand Inga Hydropower Project Feasibility Study in Congo" 2011). Construction will not close the Congo River or create tunnels, instead diverting water from the open channel. Construction will divert about 6000m3 m/s of water for the Inga III to the Bundi valley that runs parallel to the Congo riverbed. This will form a reservoir of 22,000 hectares and drown the Inga III channel. This design allows different operators to undergo development in different phases ("Grand Inga Hydroelectric Project: An Overview" n.d.). Aside from initial reports such as this, there is not set date for scheduled completion or even when construction will start.

Figure 8 (Durand 2012)

Listed as a priority project for the New Partnership for African Development (NEPAD), the South African Power Pool (SAPP), the World Energy Council, and the Southern Africa Development Community (SADC), the project will be constructed in seven phases. The Terms of Reference for the Socio and Environmental Impact Studies (SEIA) for Inga three were published in Early July 2013 for public comments and presented to the public as a feasibility study in 2013. I will draw on information from these reports, however criticisms from international organizations and local groups have described the reports as understating ecological, social, and economic risks (Ansar et al. 2014). Thus, I will compile information from these reports as well as those from third party organizations, such as International Rivers, Danwatch, and the World Bank.

Neocolonialism, Neoliberal Economics, & World Systems Theory

Some criticize the dam as a modern remnant of colonial extraction and part of a larger trend in which Europeans have ignored local land use practices, preferring to regard the African continent as a land of untapped and unlimited natural resources that can and should be extracted for human use. To begin the long history of European use of Africa as an energy source, European merchants originally extracted human energy using the Congo's estuary for the slave trade, moving on to remove biological energy through crops and timber products, and, in the mid-20th and early 21st centuries, have continued to express this will to extraction for financial gain while ignoring the environment and the needs of the rural poor via the Grand Inga Project (Showers 2011). Under World Systems Theory, this trend is part of a larger global system in which resources are extracted from the Global South for the benefit of the Global North (Bartley and Bergesen 1997, Wallerstein 1979).

Rather than a public good provided for all, neoliberal economics transformed electricity into a commodity that market forces would govern for private profit. As people increasingly viewed electricity as a "cash crop" to be produced, valued, exported and speculated upon, energy projects, specifically hydroelectric power dams, scaled up. Institutions arose to take advantage of this opportunity in connecting electricity grids and market structures. The World Bank, as the key driver behind neoliberal policy, helped create the Southern African Power Pool (SAPP) as a part of a larger effort by Southern African countries to form bureaucratic entities and legal agreements to facilitate regional electric trade (Hammons et al. 2000). These formations laid the groundwork for assessments of the Grand Inga, advancing it to both the pre-feasibility stage as well as the international stage as a regional power tool for continental interconnections.

The first two Inga dams arose from Zaire's first president, Mobuto Sese Seko, reviving Belgian colonial plans for two "small" dams in a river valley adjacent to the Congo in 1972 (Showers 2009). In 1982, the combination of Inga I's 351 MW and Inga II's 1,424 MW created the Grand Inga Dam, which supplied power to European-owned copper mines using new long-distance transmission technology. This High Voltage Long-Distance transmission technology (HVDC) resolved the issue of a market for the electricity, allowing transmission of electricity to distant consumers along "export corridors" or "electricity highways" (Hammons et al. 1998). This propelled South Africa's international electricity company Eskom Enterprises to form a consortium to build the Grand Inga III in 1999, the same year South Africa's public utility was privatized and Eskom began its journey to become Africa's largest utility (McDonald 2012). The timing of this suggests that the Grand Inga's power has never been intended for rural electrification or domestic use. Instead, it has only been intended for areas of high commercial demand - urban centers and industrial operations - and as an export commodity. As a part of a host of mega-engineering projects proposed during this time, the Inga symbolizes a continued effort to take advantage the now globalized rivers and deserts of Africa.

<u>The Grand Inga & Triple Bottom Line Sustainability: Financial, Ecological, Social</u>

Financial

Plans for the Grand Inga have continued to the present under a public/private partnership structure. Major financial contributors include the African Development Bank (AfDB) and the European Investment Bank. The World Bank approved a $73 million loan to support the project, but canceled support for the project in 2016 citing disagreements with the DRC Government's decision “to take the project in a different strategic direction” (“World Bank Group Suspends Financing to the Inga-3 Basse Chute Technical Assistance Project” 2016). The World Bank recently resumed funding of the project via its private funding arm, the International Finance Corporation, and continues to fund rehabilitation efforts of Inga I and II. Additional bidding by developers continues among Sinohydro, the Three Gorges Corporation from China, Actividades de Construcción y Servicios (ACS), Eurofinsa and AEE from Spain (Taliotis et al. 2014). The total cost of the projected cost of the Grand Inga is $80 billion. This figure, which some consider to be a considerable understatement, is six times the country’s current GDP and would likely lock the DRC in for debt that would take decades to repay (Flyvbjerg 2017).

Proponents of this project argue that this project is key to the twin development goals of creating shared prosperity and ending extreme poverty in the region (“World Bank Group Suspends Financing to the Inga-3 Basse Chute Technical Assistance Project” 2016). First, this will inject cheaper and readily available energy into the Sub-Saharan African economy, allowing the region’s manufacturing industry to take off (“Grand Inga Hydroelectric Project: An Overview” n.d.). This will drive higher rates of employment, urbanization, and a new consumer class in the region, thus fueling additional domestic economic activity. At an estimated cost of US$0.03 per kilowatt hour, this will be the most cost-effective and renewable path to achieving this development (“Transformational Hydropower Development Project Paves the Way for 9 Million People in the Democratic Republic of Congo to Gain Access to Electricity” n.d.). In outpricing fossil fuels, this would replace imported energy and increase energy security within Sub-Saharan African nations while simultaneously promoting greater regional cooperation in decisions regarding distribution and pricing.

The proposed benefits, which would allow the project to achieve both social and economic sustainability, unfortunately clash with the project’s real plans. A treaty signed in 2013 by South African President Jacob Zuma and DRC President Joseph Kabila, designed to establish an implementation framework for Inga III, made South Africa the key purchaser of electricity with the balance to go to international mining companies in the Katanga province (Vella 2014). This trickle-down approach to development has yet to find success, especially in Sub-Saharan hydropower projects (see figure below).

H.E. Matata Ponyo Mapon, the Prime Minister of the DRC argues that the Grand Inga “is one of the strategic pillars of development for the DRC, that needs energy to expand growth and reduce poverty in a sustainable way.” The World Bank concurs, with a report finding 74% of the dams who’s construction the institution had significantly supported

> are acceptable or potentially acceptable under the Bank’s current guidelines which suggests that large dams can be designed, built, and operated so as to make a positive contribution to development while protecting the environment and restoring the livelihood of people who must be resettled (McNees 1996).

While the impact of individual projects is debatable, it has not been enough to achieve the type of macroeconomic development the bank is hoping for - as illustrated in the figure below.

The countries that depend on hydropower for more than 90 percent of their electricity supply occupy the following positions on the Human Development Index (187 countries included) ("Congo's Energy Divide" 2013):

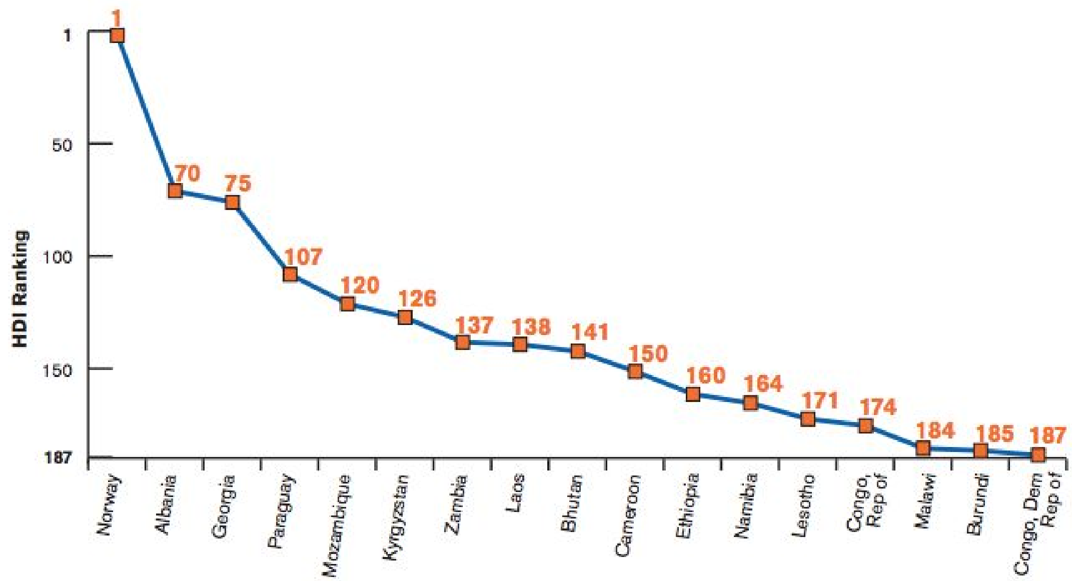

Figure 9

A long standing history of corruption in the country plants further doubt that this project will be carried out successfully. Transparency International's 2013 corruption index gave the country a score of 22 on a scale where 0 indicates the most corrupt and 100 indicates the least corrupt. It also ranked the DRC 154th out of 177 countries in perceived corruption. Charlotte Johnson, a former researcher for the African democracy watchdog Idasa, said "the various foreign investors plying the project with funding could reduce it to a minefield of corruption in a state infamous for state and political manipulation of contracts and tenders" (Sanyanda 2005). The World Bank's pulling out of the project in 2016 further weakens protection and incentives against corruption. In a report for International Rivers, Augustin Nguh concludes that there is little doubt that corruption will adversely affect the implementation of the project, given the incredible amount of money currently budgeted, construction projects' as susceptibility to corruption, and the pervasive history of corruption in the DRC (Nguh and Sanyanga 2013).

Ecological

Just as economic interests and political realities played a major role in the development of the Grand Inga, the environment has a non-negotiable role. Historically, environmental factors constrained electricity production, just as electricity production constrained, if not destroyed, ecosystem function (Showers 2011). Technological advances, like the HVDC, allowed urban exploitation of increasingly distant ecosystems. As colonial powers exploited biomass, followed by hydropower, then fossil fuels, technological innovation and changes in fuel allowed the circumvention of environmental limits (Basson 2004). Following the widespread exploitation of Sub-Saharan Africa's forest stock for energy, the Grand Inga III has replaced wood with hydroelectic power, therefore displacing environmental disruption from terrestrial to aquatic ecosystems (Bayliss and Fine 2007).

In addition to cost and reliability, proponents laud hydropower as a "green" path forward in energy development. In using water as fuel, the dam will not pollute the air as the burning of fossil fuels would. Although driving more emissions than previously understood, the Grand Inga will ultimately conserve more greenhouse gases than it will release ("Benefits of Hydropower | Department of Energy" n.d.). Estimates for this have not yet been drawn up, but will be significant through supplying 40,000 MW without combusting fossil fuels. This is an important consideration, given Africa stands to be hit the hardest by climate change and therefore has the most to gain by large scale investments in mitigation, such as the Grand Inga (Hendrix and Glaser 2007).

The potential consequences range from local to global scales. To begin, the dam would create various ecological effects within the river. Through damming the Congo River at the Inga Falls site, and thus diverting and reducing the rivers flow, the dam will effectively alter sedimentation and create new changes in flow ("Grand Inga Dam" 2017). This can alter migratory movements of fish, decrease the river's biodiversity, and change the dominant species key to maintaining balance in the food chain (Mj 2013). The Inga is vulnerable to multiple climatic conditions as well. Severe droughts, as those that happened in the 1980s and 1990s, can shatter unrestricted, low-cost hydroelectricity as well as the economic growth arising from it. The dam, in diverting water, can exacerbate droughts and water availability for locals.

On a regional scale, the dam will divert flow to create a new reservoir, flooding the Bundi Valley. Through destroying local agricultural lands and natural environments, this can create immense methane emissions that would reduce the net carbon footprint of the dam (Shirley and Kammen 2015)**.** Consistent with other still bodies of water in the area, the flooded land may be an ideal breeding ground for mosquitoes to transmit malaria. To build the necessary roads and transmission lines, construction of the dam would also necessitate the logging and cutting of large areas of forest.

Furthermore, the dam's potential disruption of the Congo Plume, created when the Congo empties into the equatorial Atlantic Ocean, stands to influence the carbon cycle on a global scale. This plume is an area of high productivity, extending nearly 800km offshore, arising from the nutrient flow from the river. This fuels phytoplankton growth and death, which sequesters carbon in the ocean floor for hundreds of years. This biological pump is critical to maintaining global carbon balances (Hopkins et al. 2013). The dam, in reducing sediment and thus the water's iron, phosphorus, and oxygen content, could reduce biological production in the Congo Plume and thus affect the state of the Atlantic Ocean as a carbon sink. Project developers that are authentically interested in sustainability must weigh these ecological consequences, including those standing to exacerbate climate change, against the proposed benefits from this project.

Social

The financial institutions supporting development of the Grand Inga have been quick to downplay concerns regarding indigenous displacement. The World Bank claims that the Grand Inga will flood the lowest land area per megawatt of electricity generated. However, the Grand Inga will produce among the highest of MW in the world, thus potentially flooding a significantly large area (“World Bank Group Supports DRC with Technical Assistance for Preparation of Inga 3 BC Hydropower Development” 2014). Hélas Cheikhrouhou, director of the Energy department at the African Development Bank, claims that the Inga projects will “follow a feasibility study and broad based consultation. The impact indicated will be quite limited on the small local population; there will be compensation for anyone displaced or otherwise adversely affected”(Mj 2013).

However, NGOs such as the Forest Peoples Programme and International Rivers have published reports stating the Grand Inga stands to displace 20,000 indigenous people (“Inga Dam in the DRC to Result in the Resettlement of up to 20,000 People | Forest Peoples Programme” 2015, “Grand Inga Hydroelectric Project: An Overview” n.d.). During the development of Inga 1 and II, indigenous people lost ancestral lands and received no compensation for this loss or the negative impacts they suffered as communities. This new Inga phase of development seems likely to repeat the cycle, as it damages the workplaces of fields and plantations, culturally important lands, and people’s homes and villages without adequate compensation. A World Bank review in 1994 found that, out of the hundreds of dams it had funded, only one provided incomes for families resettlement **(Weltbank 1994)**.

As discussed in the economics section above, the Grand Inga’s electricity will largely serve far away urban centers and industrial operations. As one of the poorest countries in the world with only 10% of its population having access to electricity, it is morally irresponsible to export electricity and to supply only to mining interests. Furthermore, while the Grand Inga’s electricity will largely bypass the Congolese people, the debt the DRC government intends to undertake will not. The DRC will feel this immense debt, likely to last for decades, in the form of increased austerity measures, higher taxes, and decreased social services. Although proponents suggest that, under classical economics, this will create a net growth in the economy, this has yet to work in a development context. I will discuss this more in my comparison of the two case studies below.

Case Study 2: Lake Turkana Wind Farm in Kenya

Project Background & Current Status

Figure 10: Google Maps 2018

The Lake Turkana Wind Power project consists of 365 wind turbines, with a combined capacity of 310 MW, which is approximately 15% of the country's installed capacity. Located between the southeast end of Lake Turkana and the foot slopes of Mt. Kulal in the Loiyangalini District of Marsabit County, Kenya, the site is about a 12 hour drive from Nairobi. Daily temperature fluctuations in the area generate strong predictable wind streams between the lake, with a relatively constant temperature, and the desert hinterland, with a steeply fluctuating temperature. This valley essentially acts as a funnel that accelerates wind streams to high speeds ("LOCATION – Lake Turkana Wind Power" n.d.).

With a price tag of 620 million Euro, this project is Kenya's biggest private investment ever. It took years to reach financial closure, but the formation of a private-public funding structure, with heavier reliance on corporate funders, has successfully created this fully operational facility. Some, like the African Development Bank and the European Union Commission, argue that this project serves as a model for development of the "green" economy in Africa, facilitating climate mitigation, economic development, and energy security simultaneously ("Lake Turkana Wind

Power Project: The Largest Wind Farm Project in Africa" 2018). Others argue that the high upfront costs, long distances between the facility and the national grid, inadequate long term feasibility data, limited technological expertise, and competing land uses will severely limit the project's effectiveness in achieving the goals stated above (Owino et al. 2016).

The project currently has all of the turbines installed and is able to produce power. However, the government utility company responsible for building the transmission line to transport the power has not yet done so. This company promises to have the transmission installed and functioning sometime this year.

Lake Turkana & Triple Bottom Line Sustainability: Financial, Ecological, Social

In this section, I will discuss the financial and social and the social and ecological aspects of this project together. Some of the largest social implications of this project surround who this project benefits, who it ignores, and who it adversely affects. These various allocations of project outcomes are intricately tied to finance. And the consequences of the outcomes are intricately tied to the ecology surrounding the project. Thus, I combine these three categories below.

Financial & Social

Financing of this project has required an "innovative" combination of assistance through investments, risk guarantees, subsidies, and debt financing. Following recommendations from the Bretton Woods Institutions, this project continues to increase independent, foreign investment in power in the country. The World Bank, an original funder, withdrew support in 2012 over concerns that output from the project at projected price points would exceed demand ("Projects: TO BE DROPPED: KENYA: Lake Turkana Wind Project | The World Bank" 2012). The African Development Bank (AfDB) then picked up the stalled project and formed a consortium of 10 other international lenders comprised of corporations and development funds from the Global North, including KP&P Africa B.V. (Netherlands), Aldwych International Ltd. (UK), Finnfund (Finland), Norfund (Norway), and Investment Fund for Developing Countries, Vestas Wind Systems (Denmark), and Google (USA) (Voller 2016). This farm will sell electricity to the the national power utility of Kenya Power & Lighting Co. (KPLC) under a 20 year power agreement ("Lake Turkana Wind Power (Kenya) - International Cooperation and Development - European Commission" 2014).

According to an environmental impact assessment, socio-economic benefits arising from the project include ("UPDATED ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT SUMMARY: Lake Turkana Wind Power Project Kenya" 2011):

1. "A stimulus to local businesses"
2. "a diversification of power.. Thus contributing to stabilising the electricity sector".
3. Rehabilitation of roads will facilitate transportation and export of local products, as well as "an increase in communication and tourism to Lake Turkana"

4. Revenue from portion of carbon credits will be given to the Government of Kenya
5. Savings of approximately 100 million euro on foreign exchange imports (heavy fuel oil)
6. Tax income of 22.7 million euro from operations
7. Temporary employment opportunities for local tribes during construction and operations phases

Some argue that this is an ideal model for "green" development in developing nations, as the funding from corporations in the Global North constitutes the region taking responsibility for climate change mitigation (Rosales 2008). Essentially, this entails companies undergoing climate change mitigation efforts in order to compensate for governments in the Global North not taking adequate action. Furthermore, without the help of these international corporations, the undertaking of this project, with its 600 million Euro price tag, would not be feasible. The AfDB states that this project is an example of "innovative financing for energy projects" through "filling the energy gap in the country" and "enhancing energy diversification" ("Lake Turkana Wind Power Project: The Largest Wind Farm Project in Africa" 2018). The European Commission's Directorate-General for International Cooperation and Development (DG DEVCO) states that the project "brings direct benefits to the Kenyan end consumer by supporting a project that will deliver over 20 years of sustainable electricity supply at a favourable rate" ("Lake Turkana Wind Power (Kenya) - International Cooperation and Development - European Commission" 2014).

The implicit assumption that the proponents of this financial model make is that, without foreign help, Kenyans would not get the electricity they need to finance economic growth. This assumption is misguided, as, under this promoted model, Kenyans cannot afford the electricity that will be produced by the Lake Turkana project and thus the stated electricity gap will continue. As stated previously, the World Bank dropped funding for the project due to concern that output would exceed demand. This is currently the case, as the cost of the electricity is too high for the majority of Kenyans, who pay the most for electricity of any African country other than Rwanda ("Energy Profile: Kenya" 2017). For this project specifically, the high electricity costs arise from a special contingency fund created by the Kenyan Government's Energy Regulatory Commission. This fund will pay the consortium in the event that Kenya Power, in whatever event, fails to pay and will be collected from consumers in the form of higher power bills (Otuki 2016). This fund may well be needed, as local newspapers report that the transmission line that the KPLC promised is yet to be built (Otuki 2017). The consortium, left with stranded power, has started billing the KPLC, which has reported that the transmission line will not be complete until 2018 (Theron 2017).

In order to reach the 77% of the population lacking access to electricity, Kenya's current economic model, which is "specifically focused on continuing to let the private sector flourish by attracting foreign direct investment alongside significant investments from large international donors", will not work (Owino et al. 2016). Furthermore, the growing sector of entrepreneurial firms in Kenya providing energy at lower costs are currently doing more than mega-projects, such as Lake Turkana, at meeting the country's electricity gap (Africa Progress Panel 2015).

The benefits for the investors appear substantial. Much of the project cost of 600 million euros will go to Vestas, the Danish firm providing the turbines. The rest of the international lenders, from Europe and North America, stand to gain substantial return on investment through shares in profits earned from the sale of electricity to KPLC in addition to the sale of carbon credits. This project intends to reduce CO_2 emissions by between 5,659,200 and 1,264,320 tons per year, generating an amount of carbon credit proportional to this. In 2007, a Certified Emission Reduction (CER) sold for approximately 10 euros. Based on this estimate, the project could generate €56,592,000 to €126,432,000 in carbon credits alone. This would be shared among the consortium of investors and a portion would be given to the Ministry of Energy, intended for use towards "the benefit of the communities living near the wind farm and along the associated transmission line" ("UPDATED ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT SUMMARY: Lake Turkana Wind Power Project Kenya" 2011).

Spotlight: Google

Google stands to gain from more than establishing a stake in this growing renewable energy market in Sub-Saharan Africa, where "we're seeing billions of dollars of investment going in" says Achim Steiner, former executive director of the UN Environment Program and UN undersecretary-general, who now leads the Oxford Martin School at Oxford University (Metz 2015). Google's stake in Lake Turkana, added to its $12 million investment in the Jasper Solar Power Project in South Africa, allows Google to facilitate additional electrification, which will result in millions of new internet users coming online annually, and thus expand markets for Google's online products (Metz 2015). Google is also able to enhance its public image in sustainability. On the company's "Green Blog", the investment description fails to mention any goal of market expansion. Instead, Rick Needham, an energy and sustainability director, describes the investment arising from the desire to "accelerate progress to a future of clean energy", provide "some of the most cost effective power in the country", and, ultimately, facilitate development in a country where both "the need and the potential are great" (Needham 2016).

Social and Ecological Impacts

The environmental impact assessment identified various social impacts as well as how the LTWP would mitigate them. Danwatch and other local news sources have noted that these predicted impacts have not been mitigated:

In terms of public health, the influx of migrant workers has increased transmission of sexually transmitted diseases, such as HIV/AIDS, and introduced indigenous communities to alcoholism and prostitution. Effluent discharge and solid waste from construction camps has polluted waterways. Additionally, the stagnant water associated with construction works/borrow pits has increased vectors of schistosomiasis and malaria (Voller 2016).

Culturally, the site area is famous for anthropological discoveries. Continued construction and maintenance within the project site, as well as that spurred by economic activity in the surrounding community, threatens artefacts and anthropological heritage.

Most seriously, the report, as all others developed by the consortium, failed to recognize the tribes in the planned site as “indigenous peoples”. Thus, the consortium was able to circumvent UN guidelines and possibly breach the Kenyan constitution. The Danwatch investigation, which sparked a letter from 38 Google investors of “deep concern” over the project, also found that the project failed to provide documentation showing that tribes in the site location were properly consulted before their land was requisitioned, therefore violating the Free, Prior, and Informed consent principle in the UN Declaration on the Rights of Indigenous Peoples. The letter, addressed to Google’s CEO, stated that investors were

> “deeply concerned by reports of violence, displacement and environmental damage associated with Lake Turkana Wind Power Project… In particular, we are seeking a deeper understanding of Google’s process for ensuring free, prior and informed consent within indigenous communities impacted by Google’s suppliers or by its own projects. (Voller 2016)”

Representatives of these indigenous people have taken the project to court over allegations of illegal land acquisition. The Lake Turkana Wind Power Group, formed by the consortium, has made detailed reports of stakeholder engagement efforts since this investigation and the start of the court case. In publishing visitation days with leaders of the local tribes, as well as elders, women, and children and documenting every project of the “Winds of Change” foundation created to help support education and health services in the area, the group aims to assure investors that they have committed no human rights abuses and they they deny “each and every allegation set out in the plaint” (Voller 2016).

This project’s projected carbon savings is the carbon equivalent of what 280,000-640,500 US citizens produce in a year. If this project is able to overcome the current court case and well as the negative press that attracted the attention of Google’s investors, it will serve as a catalyst for future renewable energy development in the region and a physical representation of Sub-Saharan Africa’s commitment to “sustainable” development.

Comparison and Discussion of Case Study Results

I looked at how renewable energy affected inequality and development within the context of the Grand Inga Dam in the DRC and the Lake Turkana Wind Power Project in Kenya. Using the Triple Bottom Line sustainability framework, I loosely analyzed the projects within the categories of economic, social, and ecological impacts. I compare these projects and their effects on inequality and development below. In regards to my framing question - “Do sustainability systems reproduce the vices of the systems they arise from?” - my research has yielded a clear answer. The systems I refer to are capitalism and neoliberalism under World Systems Theory. The vices I refer to are environmental destruction and inequality. While the two projects will likely prove effective in providing emission-free of low-emission energy, they also play a role in increasing both regional and international inequality as well as local environmental destruction. Thus, while not fully reproducing the vice of environmental destruction of capitalism, they do reproduce the vice of inequality.

Organization of Impacts	**The Grand Inga Dam**	**Lake Turkana Wind Power Project**
Financial: Investors	1. Primarily **Development Banks** - European Investment Bank & African Development Bank 2. **International Corporations** as Developer (currently in bidding process)	1. Primarily **Private Companies** - Vestas (DK), Google (US), Aldwych International Ltd (UK), KP&P Africa BV (NL) 2. **Development Funds** - Finnish Fund for All international, Norwegian Investment Fund for Developing Countries, Danish Industrial Fund for Developing Countries 3. **The Kenyan utility company** - KPLC - will finance the transmission of electricity. *All from Global North
Relation to Inequality & Development	While a portion of the revenue will go to the temporary construction jobs and later permanent maintenance jobs, the vast majority of the money involved in this project will flow from revenue in the electricity sold towards the dam co-owned by international developers and publicly owned utility company that owns the dam. From here, payments by the government on the loans used to finance the dam will go towards other international institutions, like the European Investment Bank. This largely drives global inequality, as the net flow of money for the foreseeable future	Revenue will be split among investors and KPLC. Carbon credits, the majority of which will go towards international investors, serve as a further return on investment. Currently, since KPLC has failed to build the transmission line necessary to transmit the power generated from Lake Turkana, the investors are billing KPLC. The Kenyan government is currently paying this bill and taking responsibility for the transmission line with a contingency fund formed with taxpayer money. Even in the case of a fully functioning transmission line, a large share of the revenue from this project would still be going towards investors in the Global North. Presently, all of the "revenue" is coming directly from the Kenyan

	will go towards the Global North.	government (indirectly from tax payers) and to the various investors from the Global North. This actively detracts from economic development, as the government is diverting taxpayer money away from programs more effective in engineering widespread economic development.
Social: Who Receives Electricity	**Primarily South Africa**, the remaining energy will go to **mining operations in the Katanga** province of the DRC, which are owned by the Netherlands.	**Nairobi, the largest city in Kenya**, once the transmission line is completed.
Relation to Inequality & Development	The majority of the electricity will flow out of the country, therefore largely ineffective in promoting development or reducing inequality within the DRC. One could argue that the portion going towards mining interests in the Katanga province will promote macro-economic development that will eventually trickle down to the rural poor**.** Mining, however, is widely criticised as serving as a “resource curse” in Sub-Saharan Africa, as the industry often actively detracts from economic growth, human development, and the government’s ability to respond to public needs (Auty 2002).	While one could consider this reducing inequality on a global level through supplying the energy necessary for macro-economic growth, this will largely fuel urban centers. This is problematic for both development and inequality in several ways. First, Nairobi is the domestic headquarters of many international corporations at work in Kenya. Increasing baseload energy and reliability of electricity here has benefits that extend to foreign corporations working within Kenya, through facilitating the consistency of their operations and further international extraction of wealth from the country. Second, this project bypasses both the rural and urban populations that cannot afford this power. This will directly increase wealth inequality by providing electricity, a tool used to drive the uplift of economic status, to those who can afford it, allowing them to increase their wealth and leave lower classes behind. In order to ensure lasting, steady economic development, the lower classes must also see gains.
Ecological &	Several negative externalities will	Impacts are mostly limited to the

Social: Location of Negative Externalities	be located in the geographic area surrounding the dam, including the **flooding** and e**cological destruction of the Bundi valley**, a large amount of emissions released as a result, and the **displacement** of up to 20,000 people. However, the dam will also create negative externalities on a regional level, through **altering migration patterns, dominant species, and habitat** throughout the Congo river, and on a global level, through the **disruption of the Congo plume** and a potentially global disruption in the carbon cycle.	geographic area surrounding the project. These include an **increase in transmission of HIV/AIDS** and other sexually transmitted diseases, **human rights abuses** in terms of notifying local tribes of the project and their displacement, and **increase in pollution** of local waterways.
Relation to Inequality & Development	An additional negative externality is the debt the government will incur in taking on this project, likely to be on the burden of citizens for decades to come (Sanyanga 2005). When states are unable to pay back debt, organizations like the IMF and the WB enforce structural adjustment measures. This will further inhibit the state in pursuing social services proven effective in engineering widespread economic development and in reducing inequality**.**	As stated above, the electricity will be going to a distant-urban center. For the tribes surrounding the Lake Turkana Project site, they are paying for the negative externalities of development while largely missing out of any of the benefits.

To visualize these cash flows, as well as their contribution to inequality on local, regional, and global levels, I have made the following map (Figure 11).

Figure 11


USA - Google
Norway
Finland
China - Sinohydro
United Kingdom
Denmark
Ireland
Germany
Poland
Belarus
Ukraine
Return on investment + Marketable Carbon Credits
Austria
France
Romania
Kazak
Italy
Spain
Portugal
Greece
Turkey
Uzbekista
Turkmenistan
Syria
Iraq
Iran
Afghanis
Tunisia
Morocco
Algeria
Libya
Egypt
Saudi Arabia
Western Sahara
Oman
Mauritania
Mali
Niger
Chad
Sudan
Yemen
Gulf of Aden
Arabian S
Burkina Faso
Guinea
Ghana
Nigeria
Lake Turkana Wind Power Project
Gulf of Guinea
Grand Inga Dam
Nairobi
Katanga Mining Province
Investment via loans
Angola
Zambia
Mozambique
Namibia
Zimbabwe
Madagascar
Botswana
Where energy is going
South Atlantic Ocean
South Africa

Financial Modeling of Development

The investors and project developers of these two projects have promoted these projects as "sustainable" models that can be used to fuel the long awaited economic development in Africa. However, aside from the projects' harnessing of renewable energy, there is little that makes them sustainable under the triple bottom line framework. Although categorized as separate in my analysis so far, the ecological, social, and economic implications of the these projects for the citizens of the countries involved are interconnected. They arise from the same age-old foreign direct investment model, in which a resource is harnessed and allocated according to willingness to pay, rather than proper social allocation.

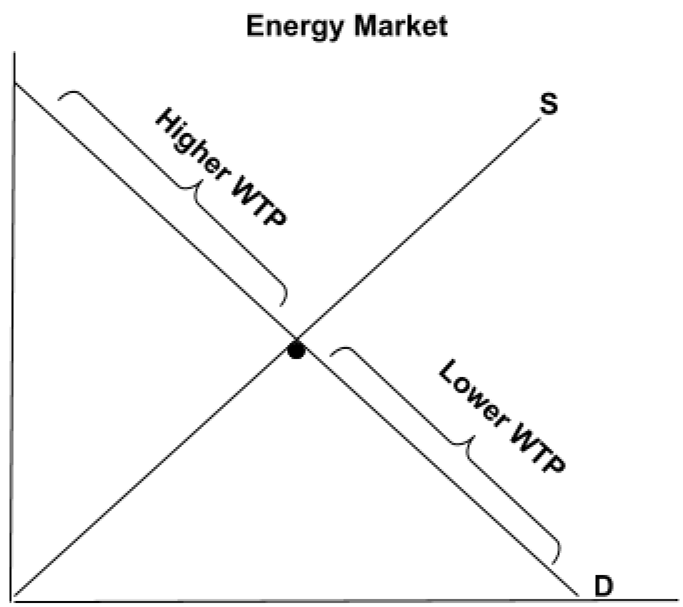

Figure 12

In allocating to those who can pay the most, electricity is thus directed towards more developed, urban areas in which people have higher incomes. In fueling the economic enterprises of upper classes, while bypassing those who cannot afford electricity, the gap in economic opportunity widens. As economic opportunity turns into profit, this gap becomes a widening wealth inequality. Thus, efficient financial allocation is fundamentally incompatible with proper social allocation. Triple bottom line sustainability frameworks, when followed, ensure socially and ecologically responsible practices that would prevent many of the negative externalities seen in the cases I have studied. However, while operating under a model that prioritizes profit and efficiency, the concerns that triple bottom line sustainability are supposed to raise are overlooked. "Sustainability" acts as a reductionist label that people accept at face value to mean wholesome social, ecological, and economic development. It stops further scrutiny of projects that are not much more than outdated models of resource exploitation.

If these projects are indeed a continuation of post-colonial extraction, then they should be advertised as such. Reducing emissions - when accompanied by human rights abuses, growing domestic and international inequality, and ecological destruction - does not make these projects sustainable nor socially responsible. Google and others have promoted these investments as a form of philanthropy, representative of the social consciousness of their respective organizations, while failing to dig behind the sustainability facade to see how these projects are not “win-wins” and benefit different actors unevenly.

In the Broader Context of Modeling Development

The Global North has a need to invest in clean energy under the ETS scheme. However, due to the higher cost of projects in the Global North as well as pre-existing fossil fuel energy infrastructure, the marginal productivity of capital, or the additional output on adding one new unit of capita “at the margin”, is very low. Thus, it is collectively efficient for the corporations and development funds of the Global North to invest in energy infrastructure abroad.

Renewable energy, although regarded as “sustainable” due to low emissions, is fundamentally no different than the industries that have historically served as a “resource curse” to Sub-Saharan Africa. As seen in the case studies above, large, international firms invest in the extraction of a resource and then sell this resource to those who can afford it, which are typically not the citizens of the country to which the resource belongs. One key difference is that renewable energy is inherently renewable for the foreseeable future. Unlike the industries of mining and fossil fuels which have set amounts and timelines of extraction, firms from the Global North can exploit the resources of wind, sun, water, and geothermal indefinitely. As this model of investment becomes increasingly popular in Sub-Saharan Africa, the returns to the Global North stand to become institutionalized.

Another issue with this model of development is that it has historically never worked. The only region in the world to reach wealth convergence with the Global North has been East Asia. Japan, South Korea, Taiwan, and more recently China financed the necessary investment in physical and, more importantly, human capital, themselves (Piketty 2014). None of these countries benefited from large foreign investments. Instead, they recognized the aspects of a global economy that were beneficial for them, which included more open markets for goods and services and advantageous terms of trade than from free capital flows. Taiwan, Japan, and South Korea all financed investment out of savings and directed investment towards human development, which suggests that the principal mechanism for convergence at the domestic as well as international level is the diffusion of knowledge. In ensuring that their people has the same level of skill, education, and technological know-how as the Global North, rather than becoming the property of them, the region was able to achieve a period of economic development that no coalition of NGOs, international corporations, or foreign governments have ever been able to engineer.

The factors that made East Asia successful in achieving sustained economic growth were closely associated with legitimate and efficient government. One could argue that the state capacity of the countries within Sub-Saharan Africa render this development mechanism infeasible. However, this same logic could be used against the current development model; one could argue that many nations in Sub-Saharan Africa lack the state capacity necessary to successfully administer mega-engineering projects. The current cases of disrepair and aggregating costs of the Inga I and II projects are prime examples. Statistical investigations that isolate variables like governance and are able to establish more significant causal relationships between governance, development, and renewable energy are needed.

Furthermore, while the current state capacity of Sub-Saharan Africa may not be at a level sufficient for the kind of launch that Southeast Asia experienced, this does not mean that the development blueprint at fault is the only one we have for the future. The historical lessons we have gained from development's successes and failures should serve to motivate a shift in focus. Structural adjustment, foreign direct investment, and free capital flows do not improve state's abilities to pay back loans or develop (CITE). Instead of instructing developing nations to prime their markets for supply-side economic policies, development organizations could redirect their resources and energy towards building governance and the economic stability necessary to finance the perpetually elusive long-term growth that the citizens of Sub-Saharan Africa deserve.

Sub-Saharan Africa, and other countries owned by other countries in both the colonial period and today, have been less successful. This is largely because they have specialized in areas, like mineral resource extraction, that simultaneously lack much prospect of future development and create political instability. When a country's economic enterprises are largely owned by foreigners, as in the DRC, there is a recurrent demand for expropriation. In the case of renewable energy, this would mean the state taking ownership of the project's electricity transmission and subsidizing the costs in order to expand access. Other political actors counter this by arguing that investment and development are only possible if existing property rights and ownership are unconditionally protected. The governments of Sub-Saharan Africa have thus alternated between governments dedicated to protecting the rights of existing, foreign property owners and revolutionary governments, who achieve limited success in improving the living conditions of their citizens. While this cycle continues to inhibit human development in an entire region of our planet, international firms and development organizations continue to receive income from their investments and use technological developments to expand their industrial reach.

> "Inequality is already difficult to accept and peacefully maintain within a single national community. Internationally, it is almost impossible to sustain without a colonial type of political domination" (Piketty 2014).

Next Steps | Further Research

In order to expand electricity access while reducing emissions, states and investors can pursue other forms of renewable energy projects that have proven more effective in reducing inequality and driving economic development. In contrast to the dominant model of mega-engineering projects, centralized power systems, and their influence on indicators like GNP, small-scale entrepreneurial renewable projects, like micro-hydro and rooftop solar, have provided an example of macroeconomic benefit accruing from small scale projects (Karekezi 2002, Paish 2002). Tunisia, for example, extended their national grid to rural areas, which reduced health care costs, decreased urban migration, and stimulated small businesses (Cecelski et al. 2005). Contrary to criticisms of being “uneconomic” or expensive social welfare, Tunisia serves as an example of economic benefit at a national level arising from accrued rural and dispersed development.

These small-scale development models are short-term solutions, that serve to “minimize pain” in fighting for a more fair allocation of resources (Wallerstein 2011). However, the structural issues within renewable energy projects did not arise in a vacuum. The governments of Sub-Saharan Africa, in addition to the rest of the global south, are increasingly indebted, lacking financial resources, and at risk for multiple environmental problems: climate change, vast pandemics, and nuclear war. In order to address the growing global inequality in power and resources that exacerbates the challenges facing peripheral nations, Immanuel Wallerstein, the creator of World Systems Theory, has made several propositions (Wallerstein 2011):

1. The categorical rejection of economic growth and replacement of it with the end goal of maximum decommodification of education, health structures, the body, water, air, agricultural production, etc. via wide experimentation.
2. The creation of local and regional self-sufficiencies that allow for multiple universalisms.
3. The aggressive pursuit of ending fundamental social inequalities.

In terms of creating a lasting change that goes beyond sustainability and towards a more equitable economic system, these are long term efforts that will require extensive research, experimentation, and will power.

To build on the research I have done here, I would look deeper into the causal relationships between renewable energy and development indicators, in order to determine how exactly renewable energy fits into “sustainable development” and what additional programs need to accompany renewable energy projects in order to ensure equitable results. Additional research is also needed on development models. The status quo, or models based on trickle-down economics, have not worked for Sub-Saharan Africa and show no promise of driving more positive results in the future. Instead, post-development should focus more on research into different suites of development strategies that target different components of human development at once.

Bibliography

“About the World Bank.” n.d. Text/HTML. World Bank. http://www.worldbank.org/en/about.

Ackom, Emmanuel K., Dieudonne Alemagi, Nana B. Ackom, Peter A. Minang, and Zac Tchoundjeu. 2013. “Modern Bioenergy from Agricultural and Forestry Residues in Cameroon:

Potential, Challenges and the Way Forward." Energy Policy 63 (December): 101–13. https://doi.org/10.1016/j.enpol.2013.09.006.

"Aecom, EDF Partner for Grand Inga Hydropower Project Feasibility Study in Congo." 2011.

Auty, Richard. 2002. Sustaining Development in Mineral Economies: The Resource Curse Thesis. Routledge.

Bartley, Tim, and Albert Bergesen. 1997. "World-System Studies of the Environment." Journal of World-Systems Research 3 (3): 369–80. https://doi.org/10.5195/jwsr.1997.97.

Basson, Gerrit. 2004. "Hydropower Dams and Fluvial Morphological Impacts–an African Perspective." In Paper from United Nations Symposium on Hydropower and Sustainable Development, 27–29.

Bayliss, K., and B. Fine. 2007. Privatization and Alternative Public Sector Reform in Sub-Saharan Africa: Delivering on Electricity and Water. Springer.

"Benefits of Hydropower | Department of Energy." n.d. Accessed February 20, 2018.

Bornschier, Volker, Christopher Chase-Dunn, and Richard Rubinson. 1978. "Cross-National Evidence of the Effects of Foreign Investment and Aid on Economic Growth and Inequality: A Survey of Findings and a Reanalysis." *American Journal of Sociology* 84 (3): 651–83.

Brunn, Stanley D. 2011. Engineering Earth: The Impacts of Megaengineering Projects. Springer Science & Business Media.

Caselli, Francesco, Gerardo Esquivel, and Fernando Lefort. 1996. "Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics." Journal of Economic Growth 1 (3): 363–89. https://doi.org/10.1007/BF00141044.

Cecelski, Elizabeth, Ahmed Ounalli, Moncef Aisaa, and Joy Dunkerley. 2005. "Rural Electrification in Tunisia : National Commitment, Efficient Implementation and Sound Finances." ESM307. The World Bank.

Chibambo, Charles Odoi. 2017. "'Electricity Supply to Africa and Developing Economies: Challenges and Opportunities.' Enabling Universal Access to Electricity in Developing Countries." *8th Southern Africa Regional Conference*, November.

Clémençon, Raymond. 2016. "The Two Sides of the Paris Climate Agreement: Dismal Failure or Historic Breakthrough?" The Journal of Environment & Development 25 (1): 3–24. https://doi.org/10.1177/1070496516631362.

"Congo's Energy Divide." 2013. Berkeley, CA: International Rivers.

Cusick,ClimateWire, Daniel, and Daniel Cusick,ClimateWire. 2017. “Why Google Cares about Wind Power in Africa.” Scientific American.

“Developing Countries and the Renewable Energy Revolution - OECD.” n.d. Organization for Economic Coordination and Development. Accessed September 21, 2017.

Dincer, Ibrahim. 2000. “Renewable Energy and Sustainable Development: A Crucial Review.” Renewable and Sustainable Energy Reviews 4 (2):157–75.

Dinkelman, Taryn. 2011. “The Effects of Rural Electrification on Employment: New Evidence from South Africa.” American Economic Review 101 (7): 3078–3108. https://doi.org/10.1257/aer.101.7.3078.

Dunmade, Israel. 2002. “Indicators of Sustainability: Assessing the Suitability of a Foreign Technology for a Developing Economy.” Technology in Society 24 (4): 461–71. https://doi.org/10.1016/S0160-791X(02)00036-2.

Durand, Philippe. 2012. “Integrated Safeguards Data Sheet Concept Stage.” Basic Project Data

Inga 3 and Mid-Size Hydropower Development. World Bank. 2016.

“Energy Profile: Kenya.” 2017. Kenya: United Nations Environment Program.

Erken, Arthur, Mercedes Mateo Diaz, and Robert Engelman. 2017. “The State of the World Population.” United Nations Population Fund.

Ferreyra, Cecilia, and Mark T. Brown. 2007. “Energy Perspectives on the Argentine Economy during the 20th Century: A Tale of Natural Resources, Exports and External Debt.” *International Journal of Environment and Sustainable Development* 6 (1): 17–35.

Flyvbjerg, Bent. 2017. The Oxford Handbook of Megaproject Management. Oxford University Press.

Ghirmay, Teame. 2004. “Financial Development and Economic Growth in Sub-Saharan African Countries: Evidence from Time Series Analysis.” African Development Review 16 (3): 415–32. https://doi.org/10.1111/j.1017-6772.2004.00098.x.

Global Report on Human Settlements. 2013. Planning and Design for Sustainable Urban Mobility. Un-Habitat.

Graaf, Thijs Van de, Benjamin K. Sovacool, Arunabha Ghosh, Florian Kern, and Michael T. Klare. 2016. The Palgrave Handbook of the International Political Economy of Energy. Springer.

Gottschalk, Keith. 2016. “Hydro-Politics and Hydro-Power: The Century-Long Saga of the Inga Project.” Canadian Journal of African Studies / Revue Canadienne Des études Africaines 50 (2): 279–94. https://doi.org/10.1080/00083968.2016.1222297.

Graça Carvalho, Maria. 2012. EU energy and climate change strategy. Energy 40, no. 1 : 19-22.

"Grand Inga Hydroelectric Project: An Overview." n.d. International Rivers. Accessed February 19, 2018.

Gujba, Haruna, Steve Thorne, Yacob Mulugetta, Kavita Rai, and Youba Sokona. 2012. "Financing Low Carbon Energy Access in Africa." Energy Policy, Universal access to energy: Getting the framework right, 47 (June): 71–78. https://doi.org/10.1016/j.enpol.2012.03.071.

Halpern, Benjamin S., Carissa J. Klein, Christopher J. Brown, Maria Beger, Hedley S. Grantham, Sangeeta Mangubhai, Mary Ruckelshaus, et al. 2013. "Achieving the Triple Bottom Line in the Face of Inherent Trade-Offs among Social Equity, Economic Return, and Conservation." Proceedings of the National Academy of Sciences 110 (15):6229–34. https://doi.org/10.1073/pnas.1217689110.

Hammons, T. J., B. K. Blyden, A. C. Calitz, A. B. Gulstone, E. Isekemanga, R. Johnstone, K. Paluku, N. N. Simang, and F. Taher. 2000. "African Electricity Infrastructure Interconnections and Electricity Exchanges." IEEE Transactions on Energy Conversion 15 (4): 470–80. https://doi.org/10.1109/60.900510.

Hammons, T. J., F. Taher, N. I. Voropai, L. S. Belyaev, S. V. Podkovalnikov, G. V. Shutov, D. Povh, et al. 1998. "International High-Voltage Grids and Environmental Implications." IEEE Power Engineering Review 18 (8): 4–4. https://doi.org/10.1109/MPER.1998.691389.

Harries, Mike. 2002. "Disseminating Wind Pumps in Rural Kenya—meeting Rural Water Needs Using Locally Manufactured Wind Pumps." Energy Policy, Africa: Improving Energy Services for the Poor, 30 (11): 1087–94. https://doi.org/10.1016/S0301-4215(02)00060-5.

Harrison, Graham. 2004. The World Bank and Africa: The Construction of Governance States. Routledge.

Harvey, David. 2007. "Neoliberalism as Creative Destruction." The ANNALS of the American Academy of Political and Social Science 610 (1):21–44. https://doi.org/10.1177/0002716206296780.

Haselip, James, Ivan Nygaard, Ulrich Hansen, and Emmanuel Ackom. 2011. "Diffusion of Renewable Energy Technologies: Case Studies of Enabling Frameworks in Developing Countries." Technology Transfer Perspectives. Denmark: United Nations Environment Program.

Hendrix, Cullen S., and Sarah M. Glaser. 2007. "Trends and Triggers: Climate, Climate Change and Civil Conflict in Sub-Saharan Africa." Political Geography, Climate Change and Conflict, 26 (6): 695–715. https://doi.org/10.1016/j.polgeo.2007.06.006.

Hopkins, Jo, Marc Lucas, Claire Dufau, Marion Sutton, and Olivier Lauret. 2013. "Detection and Variability of the Congo River Plume from Satellite Derived Sea Surface Temperature, Salinity, Ocean Colour and Sea Level." Remote Sensing of Environment 139 (April): 3135. https://doi.org/10.1016/j.rse.2013.08.015.

IEA. 2017. World Energy Outlook 2017. World Energy Outlook. IEA. http://www.oecd-ilibrary.org/energy/world-energy-outlook-2017_weo-2017-en.

"Inga Dam in the DRC to Result in the Resettlement of up to 20,000 People | Forest Peoples Programme." 2015. Forest Peoples Programme. June 2015.

Intergovernmental Panel on Climate Change. 2014. Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects: Working Group II. Contribution to the IPCC Fifth Assessment Report. Vol. 1. Cambridge: Cambridge University Press. doi:10.1017/CBO9781107415379.

IRENA. 2017. "Stranded assets and renewables: how the energy transition affects the value of energy reserves, buildings and capital stock", International Renewable Energy Agency (IRENA), Abu Dhabi, www.irena.org/remap

Jaeger, Joel. 2017. "China Is Leaving the U.S. Behind on Clean Energy Investment." World Resources Institute. January 6, 2017.

Kabo-Bah, Amos, and Chukwuemeka J. Diji. 2018. Sustainable Hydropower in West Africa: Planning, Operation, and Challenges. Academic Press.

Kalicki, Jan H., and David L. Goldwyn. 2013. Energy and Security: Strategies for a World in Transition. Johns Hopkins University Press.

Karekezi, Stephen. 2002. "Renewables in Africa—meeting the Energy Needs of the Poor." Energy Policy, Africa: Improving Energy Services for the Poor, 30 (11): 1059–69. https://doi.org/10.1016/S0301-4215(02)00058-7.

Kitson, A. E. 1925. Outline of mineral and water-power resources of the Gold Coast, British West Africa. Gold Coast Geological Survey Bulletin 1.

Klamer, Arjo, Deirdre N. McCloskey, and Robert M. Solow. 1988. *The Consequences of Economic Rhetoric*. Cambridge University Press.

Komendantova, Nadejda, Anthony Patt, Lucile Barras, and Antonella Battaglini. 2012. "Perception of Risks in Renewable Energy Projects: The Case of Concentrated Solar Power in North Africa." Energy Policy, Strategic Choices for Renewable Energy Investment, 40 (January): 103–9. https://doi.org/10.1016/j.enpol.2009.12.008.

"Lake Turkana Wind Power (Kenya) - International Cooperation and Development - European Commission." 2014. European Commission: International Cooperation and Development. December 18, 2014.

"Lake Turkana Wind Power Project: The Largest Wind Farm Project in Africa." 2018. African Development Bank.

"LOCATION – Lake Turkana Wind Power." n.d. Lake Turkana Wind Power (blog). Accessed February 21, 2018.

Mberu, Blessing Uchenna, and Alex Chika Ezeh. 2017. "The Population Factor and Economic Growth and Development in Sub-Saharan African Countries." African Population Studies 31 (2). https://doi.org/10.11564/31-2-1056.

McDonald, David A. 2012. Electric Capitalism: Recolonising Africa on the Power Grid. Routledge.

McEwan, Cheryl. 2017. "Spatial Processes and Politics of Renewable Energy Transition: Land, Zones and Frictions in South Africa." Political Geography 56 (Supplement C):1–12.

Mkandawire, P. Thandika, and Charles Chukwuma Soludo. 1999. *Our Continent, Our Future: African Perspectives on Structural Adjustment*. IDRC.

McNees, Pat. 1996. "World Bank Lending for Large Dams : A Preliminary Review of Impacts." 28695. The World Bank.

Metz, Cade. 2015. "Google Pumps Funds Into Africa's Biggest Wind Power Project." WIRED. October 20, 2015.

Mj, Morgan. 2013. "The Grand Inga Dam: Can It Be the Mother of Africa's Development Solutions? | HighBeam Business: Arrive Prepared." New African. May 2013.

Msimanga, B., and A. B. Sebitosi. 2014. "South Africa's Non-Policy Driven Options for Renewable Energy Development." Renewable Energy 69 (September): 420–27. https://doi.org/10.1016/j.renene.2014.03.041.

Needham, Rick. 2016. "Investing in Africa's Largest Wind Project." Google Green Blog (blog). 2016.

Negro, Simona O., Floortje Alkemade, and Marko P. Hekkert. 2012. "Why Does Renewable Energy Diffuse so Slowly? A Review of Innovation System Problems." Renewable and Sustainable Energy Reviews 16 (6): 3836–46. https://doi.org/10.1016/j.rser.2012.03.043.

Newell, Peter, and Harriet Bulkeley. 2017. "Landscape for Change? International Climate Policy and Energy Transitions: Evidence from Sub-Saharan Africa." Climate Policy 17 (5): 650–63. https://doi.org/10.1080/14693062.2016.1173003.

Nguh, Augustin, and Rudo Sanyanga. 2013. "Corruption and Infrastructure Megaprojects in the DR Congo." International Rivers.

Nørgaard, Rune. 2017. “ABOUT IFU.” Investeringsfonden for Udviklingslande. IFU (blog). 2017.

Odhiambo, Nicholas M. 2009. “Energy Consumption and Economic Growth Nexus in Tanzania: An ARDL Bounds Testing Approach.” Energy Policy 37 (2): 617–22. https://doi.org/10.1016/j.enpol.2008.09.077.

Odhiambo, Nicholas M. 2016. “Coal Consumption and Economic Growth in South Africa: An Empirical Investigation.” Energy & Environment 27 (2): 215–26. https://doi.org/10.1177/0958305X15627535.

Odihi, J. "Deforestation in afforestation priority zone in Sudano-Sahelian Nigeria." Applied Geography 23, no. 4 (2003): 227-259.

Otuki, Neville. 2016. “Turkana Wind Power Deal Leaves Consumers Sh4.6b Burden.” Daily Nation. February 2016.

Otuki, Neville. 2017. “Kenya Power Billed for Idle Wind Farm.” Business Daily Africa. 2017.

Owino, Tom, Ries Kamphof, Ernst Kuneman, Xander van Tilburg, Louise van Schaik, and James Rawlins. 2016. “Towards a Green Trajectory of Economic Growth and Energy Security in Kenya.” The Hague, Netherlands: Clingendael.

Packenham, Robert A. 2015. *Liberal America and the Third World: Political Development Idea in Foreign Aid and Social Science*. Princeton University Press.

Paish, Oliver. 2002. “Small Hydro Power: Technology and Current Status.” Renewable and Sustainable Energy Reviews 6 (6): 537–56. https://doi.org/10.1016/S1364-0321(02)00006-0.

Pasqualetti, Martin J. 2011. “The Geography of Energy and the Wealth of the World.” Annals of the Association of American Geographers 101 (4): 971–80.

Parkhurst, Maggie. 2017. “Corporate Social Responsibility — How Renewables Have Expanded the Field.” Renewable Energy World. May 17, 2017.

Pearce, Fred. 2015. “African Lights: Solar Microgrids Bring Power to Kenyan Villages.” Yale School of Forestry and Environmental Studies. 2015.

Africa Progress Panel. 2015. Power, People, Planet. Seizing Africa’s Energy and Climate Opportunities: Africa Progress Report 2015. Geneva: Africa Progress Panel.

Piketty, Thomas. 2014. Capital in the Twenty-First Century. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

Piketty, Thomas, and Gabriel Zucman. 2014. “Capital Is Back: Wealth-Income Ratios in Rich Countries 1700–2010 *.” The Quarterly Journal of Economics 129 (3):1255–1310.

"Power Africa in Democratic Republic of the Congo | Power Africa | U.S. Agency for International Development." 2018. USAID. 2018.

"Projects: TO BE DROPPED: KENYA: Lake Turkana Wind Project | The World Bank." n.d. Accessed February 21, 2018.

Quah, D., 1993. Empirical cross-section dynamics in economic growth. European Economic Review 37, 2–3.

Ridder, Marjolein de, Magnus Ericsson, Artur Usanov, Wilem Auping, Stephanie Lingemann, Luis Tercero Espinoza, Masuma Farooki, Henrike Sievers, and Maren Liedtke. 2013. Coltan, Congo and Conflict: Polinares Case Study. The Hague Centre for Strategic Studies.

Rosales, Jon. 2008. "Economic Growth, Climate Change, Biodiversity Loss: Distributive Justice for the Global North and South." Conservation Biology 22 (6): 1409–17. https://doi.org/10.1111/j.1523-1739.2008.01091.x.

Sanyanga, Rudo. 2005. "Grand Inga, Grand Illusions?" International Rivers 20 (2):6–7.

Sanyanga, Rudo. 2013. "Will Congo Benefit from Grand Inga Dam?" International Policy Digest (blog).June 29, 2013.

Schwerhoff, Gregor, and Mouhamadou Sy. 2017. "Financing Renewable Energy in Africa – Key Challenge of the Sustainable Development Goals." Renewable and Sustainable Energy Reviews 75 (August): 393–401. https://doi.org/10.1016/j.rser.2016.11.004.

Senker, Peter. 2011. "Prosperity without Growth: Economics for a Finite Planet. Tim Jackson, London and Washington DC, Earthscan, 2011." *Energy & Environment* 22 (7): 1013–16.

Shi, Tian. 2004. "Ecological Economics as a Policy Science: Rhetoric or Commitment towards an Improved Decision-Making Process on Sustainability." *Ecological Economics* 48 (1): 23–36.

Shirley, Rebekah, and Daniel Kammen. 2015. "Energy Planning and Development in Malaysian Borneo: Assessing the Benefits of Distributed Technologies versus Large Scale Energy Mega-Projects." Energy Strategy Reviews 8 (July): 15–29. https://doi.org/10.1016/j.esr.2015.07.001.

Showers, Kate B. 2009. "Congo River's Grand Inga Hydroelectricity Scheme: Linking Environmental History, Policy and Impact." Water History 1 (1): 31–58. https://doi.org/10.1007/s12685-009-0001-8.

Smil, Vaclav. 2005. Energy at the Crossroads: Global Perspectives and Uncertainties. MIT Press.

Sovacool, Benjamin K., and Ira Martina Drupady. 2016. Energy Access, Poverty, and Development: The Governance of Small-Scale Renewable Energy in Developing Asia. Routledge.

Speth, James Gustave. 2008. The Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability. Yale University Press.

Steil, Benn. 2013. *The Battle of Bretton Woods: John Maynard Keynes, Harry Dexter White, and the Making of a New World Order*. Princeton University Press.

Starr, Joyce R. 1991. “Water Wars.” *Foreign Policy*, no. 82: 17–36.

Steffen, Bjarne, and Tobias S. Schmidt. 2017. The role of public investment & development banks in enabling or constraining new power generation technologies. In European Energy Market (EEM). 14th International Conference: 1-6

Stiglitz, Joseph E. 2003. Globalization and Its Discontents. W. W. Norton & Company.

Taliotis, Constantinos, Morgan Bazilian, Manuel Welsch, Dolf Gielen, and Mark Howells. 2014. “Grand Inga to Power Africa: Hydropower Development Scenarios to 2035.” Energy Strategy Reviews 4: 1–10.

Torres-Duque, Carlos, Darío Maldonado, Rogelio Pérez-Padilla, Majid Ezzati, and Giovanni Viegi. "Biomass fuels and respiratory diseases: a review of the evidence." Proceedings of the American Thoracic Society 5, no. 5 (2008): 577-590.

Theron, Ashley. 2017. “Lake Turkana Turbines to Remain Inactive until 2018.” ESI Africa: Africa’s Power Journal. June 2017.

“Transformational Hydropower Development Project Paves the Way for 9 Million People in the Democratic Republic of Congo to Gain Access to Electricity.” n.d. Text/HTML. World Bank. Accessed February 20, 2018.

“Transforming Our World: The 2030 Agenda for Sustainable Development .:. The United Nations.” 2015. Sustainable Development Knowledge Platform. 2015. https://sustainabledevelopment.un.org/post2015/transformingourworld.

UNDP, ed. 2015. Work for Human Development. Human Development Report 2015. New York, NY: United Nations Development Programme.

“UPDATED ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT SUMMARY: Lake Turkana Wind Power Project Kenya.” 2011. E2910. Kenya: World Bank.

Vella, Heidi. 2014. “Mining the DRC – Doing Business in the World’s Second Least Developed Country.” Mining Technology (blog). October 1, 2014.

Venage, Gavin. 2017. “Investors Take an Interest in Africa’s Dam Building.” The National. April 2017.

Vidal, John. 2013. “DR Congo Waits on Funding for World’s Largest Hydropower Project.” The Guardian.

Voller, Louise. 2016. “Google Investors ‘Deeply Concerned’ over Human Rights Violations in Kenyan Wind Project.” Danwatch. 2016.

Vries, B. J. M. de, D. P. van Vuuren, and M. M. Hoogwijk. 2007. “Renewable Energy Sources: Their Global Potential for the First-Half of the 21st Century at a Global Level: An Integrated Approach.” Energy Policy 35 (4): 2590–2610.

Vuuren, Detlef P. van, Elke Stehfest, David E. H. J. Gernaat, Jonathan C. Doelman, Maarten van den Berg, Mathijs Harmsen, Harmen Sytze de Boer, et al. 2017. “Energy, Land-Use and Greenhouse Gas Emissions Trajectories under a Green Growth Paradigm.” Global Environmental Change 42 (January): 237–50. https://doi.org/10.1016/j.gloenvcha.2016.05.008.

Wallerstein, Immanuel. 1979. *The Capitalist World-Economy*. Cambridge University Press.

Wallerstein, Immanuel Wallerstein Topics: Economic, History, Political Economy, and Stagnation. 2011. “Structural Crisis in the World-System: Where Do We Go from Here? | Immanuel Wallerstein.” Monthly Review (blog). March 1, 2011.

Weltbank, ed. 1994. Infrastructure for Development. 1. pr. World Development Indicators 17. Oxford: Oxford Univ. Press.

Wilson, Ernest J. 1987. “World Politics and International Energy Markets.” Edited by Hans Jacob Bull-Berg, Magne Holter, Peter Cowhey, Martin Greenberger, Wilfred Kohl, William Quandt, Steven Schneider, et al. International Organization 41 (1):125–49.

Winkler, Bastian, Stefanie Lemke, Jan Ritter, and Iris Lewandowski. "Integrated assessment of Renewable energy potential: Approach and application in rural South Africa." Environmental Innovation and Societal Transitions 24 (2017): 17-31.

“World Bank Pulls Funding for Congo’s Inga-3 Hydropower Project.” 2016. Reuters. 2016.

“World Bank Group Supports DRC with Technical Assistance for Preparation of Inga 3 BC Hydropower Development.” 2014. Text/HTML.

“World Bank Group Suspends Financing to the Inga-3 Basse Chute Technical Assistance Project.” 2016. Text/HTML. World Bank. 2016.

Wüstenhagen, Rolf, and Emanuela Menichetti. 2012. “Strategic Choices for Renewable Energy Investment: Conceptual Framework and Opportunities for Further Research.” Energy Policy,

Strategic Choices for Renewable Energy Investment, 40 (January): 1–10.
https://doi.org/10.1016/j.enpol.2011.06.050.

Appendix

RE	Renewable electricity output (% of total electricity output)
GDPC	GDP per capita (current US$)
PHR	Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)
ExDS	External debt stocks (% of GNI)
GPI	School enrollment, primary and secondary (gross), gender parity index (GPI)

Year	Time Series as X	RE	GDPC	PHR	ExDS	GPI
1990	1	71.216	602.839	54.4	61.872	0.814
1991	2	71.899	604.726		61.463	0.822
1992	3	72.511	578.423		62.372	0.828
1993	4	73.416	539.097	59	67.818	0.829
1994	5	73.953	510.879		81.413	0.831
1995	6	73.576	574.110		74.492	0.831
1996	7	72.676	577.806	58.1	70.445	0.835
1997	8	71.882	582.671		66.140	0.835
1998	9	72.475	534.831		71.148	0.833
1999	10	72.815	524.612	57.6	66.893	0.840
2000	11	72.985	548.399		62.666	0.841
2001	12	72.939	496.890		64.456	0.846
2002	13	72.346	518.584	56.1	65.588	0.842
2003	14	71.668	644.765		56.049	0.850
2004	15	71.466	782.291		48.018	0.855
2005	16	71.162	894.622	50.3	37.482	0.865
2006	17	71.381	1019.754		26.848	0.875
2007	18	71.057	1154.835		26.592	0.880
2008	19	70.934	1284.750	46.9	23.596	0.889

2009	20	70.977	1197.374		27.322	0.897
2010	21	71.509	1557.816		22.396	0.904
2011	22	71.085	1706.005	46.9	22.048	0.901
2012	23	70.353	1740.520		23.584	0.906
2013	24	69.986	1783.981		24.593	0.911
2014	25	70.216	1819.464		24.366	0.912