BBDP – The Bolivian Biogas Development Proposal

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Submitted to the Center of Global Affairs of New York University in Partial Fulfillment of the Requirements for the Master of Science in Global Affairs

Authored by Tanner Kenney

Advised and Reviewed by Prof. William Powers

Spring 2016

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1. Abstract

BBDP seeks to fund the sustainable development of biogas resources for use as a vehicle fuel, onsite electricity generation, and eventual pipeline. The proposal recognizes the German government's decision to eliminate nuclear power from its energy generation portfolio by 2022 as a threat to the nation's GHG emissions reduction strategy. As a net-importer of NG, the proposal recommends Germany assist in constructing this mechanism in Bolivia – a net NG exporting nation and a historical partner in cultural, economic, and political exchange. BBDP creates a sustainable model for governmental ministries and private sector companies in both nations to invest in biogas upgrading, utilization, and transport technologies in Bolivia.

Essentially, the purpose of BBDP is to create a tool for German GHG emissions reductions via a biogas capturing and upgrading system beginning with the AD of organic waste at the El Ceibo Chocolate Company in El Alto. German companies are to be contracted for the construction of biogas utilization technologies at the cooperative and, once the pilot has proven successful, BBDP will expand to nearby commercial, municipal, and residential waste collection sites for capture/digestion and upgrading. The proposal is then intended to be expanded across the nation's agricultural, energy, and transportation sectors, ultimately including the production of organic fertilizers, educational and training programs, and more.

BBDP agrees with several concerns raised by anthropologist Arturo Escobar in ED and posits retorts to some of the post-development claims made by the author in favor of de-growth. These arguments are supported by the tenets of the school of sustainable development and its discourse such as the beneficial effects of CSR, generating equations to determine liability for development-related pollution, the necessity for cross-border environmental remediation, and beyond. The proposal is made in recognition of the necessity developing climate change-abating technologies in emerging economies and their disproportionate responsibility for developing ecological remediation tactics in the face of mounting climatological concerns.

The proposal is to be funded in its entirety through R&D loans from the German government which. in turn, can be recouped with offsetting credits from the EU ETS, thereby providing additional support for the faltering carbon marketplace. German ministries such as the Society for International Cooperation will work in tandem with the Bolivian Ministry of Hydrocarbons and Energy to coordinate with YPFB and German private sector companies involved with the construction and operation of BBDP facilities. NGO's and think tanks will

provide continuing assistance via consultative and technical services such as the measurement of economic and environmental impact of BBDP as well as the ongoing performance of RNG facilities. CSR programming and charitable institutions will provide continuing funding for the education and training program arm of the proposal, BATTS, in order to ensure the inclusion of indigenous Bolivians in perpetuity.

The structure of BBDP is both academic and technical in nature in that its proposals are made with support from the modern sustainable development discourse, countering several positions taken by Arturo Escobar throughout ED in support of Post-Development theories. Both elements of BBDP are intended to support one another by demonstrating the need for the promotion of renewable energy technologies in all nations, regardless of development status. Its contents are of import to the field of global affairs due to their reliance on intergovernmental cooperation and international market fluctuations (e.g. commodities, industry, and technology). Moreover, the proposal's recommendations for international cooperation on promoting technological advancement in energy production as well as its relationship to the climate and environment outline the necessity for immediate action.

BBDP is the accumulation of the author's knowledgebase in the subjects of energy, environment, global affairs, and transportation systems. The resources for the contents of BBDP come in various forms, including primary texts (i.e. Escobar and a *Financial Times*' special edition), technical reports, op-ed publications, and scholarly articles. Additionally, the conclusions drawn and recommendations made by BBDP are supported by in-person and technologically-mediated interviews with professionals from several nations working in fields related to energy, climate and environment, government, indigenous populations, international relations, and beyond. A review of existing literature regarding the subjects contained in BBDP is presented throughout the proposal as it relates to a specific topic.

2. Introduction

Climate Change

Exploration has long been held as the primary tool for the advancement of society and progression of humanity.[1] Whether it be for new land, natural sources, or the pursuit of personal enjoyment, the practice has promulgated unprecedented success in many areas such as agriculture, healthcare, and industry. These tools of development have brought societies a great number of benefits in both their basic and modern forms, yet have a tremendous impact on the global climate.[2] Recently, efforts to curtail waste in the energy generation and transportation[3] sectors through the development of renewable energy sources[4] such as distributed[5] and stored[6] electrical systems have assisted in reducing global GHG emissions. But there is still much work to be done in promoting sustainability in a variety of industries as efficiency measures,[7] alone, will not be enough to achieve the goal of capping emissions to prevent a global rise in temperatures of more than 2 degrees Celsius – a target climatologists agree is necessary to prevent irreparable damage to the environment.[8]

Beginning with the advent of the internal combustion engine, the interest in addressing concerns related to pollution from tailpipe emissions (e.g. the fine particulate matter released during the compression of diesel fuel)[9] has been piqued, particularly in regards to fuel additives, blending, and sourcing through performance-related technologies. Generational advancements are highlighted in the transition from coal-fired, steam-powered engines to those which ran gasoline and lead, to the latter's replacement – MBTE[10] – to the introduction of biofuels into the mixture.[11] But the missteps taken when making these incremental changes have proven costly to the environment[12] and motorists,[13] alike, and the process of advanced fuel production methods

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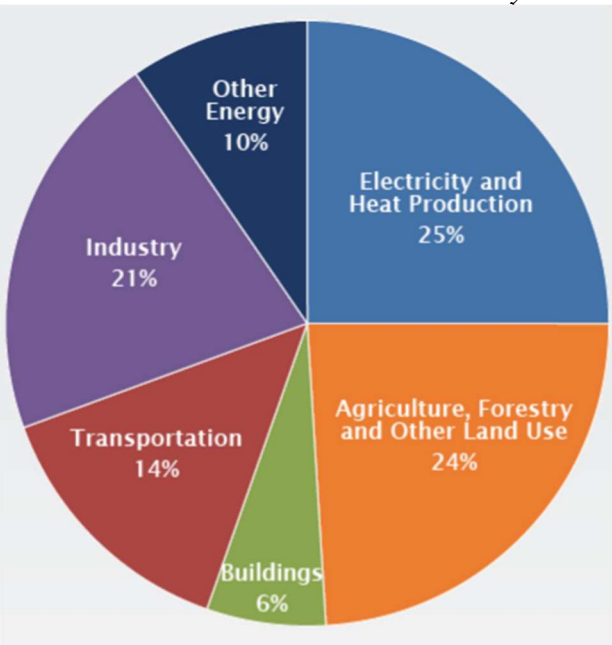
[1] The Importance of Exploration
[2] Environmental and Ecological Effects of Energy Production and Consumption – Chapter 2, Alternative Energy Sources
[3] Tesla Motors
[4] Costa Rica hasn't used any fossil fuels for electricity so far in 2015
[5] What is Distributed Generation?
[6] Thermal Energy Storage – Technology Brief (E17)
[7] Energy efficiency
[8] The Emissions Gap Report
[9] Diesel Particulate Matter
[10] Fuel Blending: Capture the Potential of Non-Recyclable Waste
[11] Renewable Fuels: Regulations & Standards
[12] Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcanes, and cellulosic biomass for US use
[13] The Hidden Corn Ethanol Tax – How Much Does the Renewable Fuel Standard Cost Motorists

must be accelerated to meet the growing demands of the global population whilst balancing economic and environmental concerns. [14]

Global GHG emissions contributions by sector.



[15]

Given the implications that climate change presently poses, drastic measures of adaptation, mitigation, and remediation will be necessary to prevent disaster on a global scale.[16] These tools must take into account the whole-life cost of development practices – to which agriculture, energy production, and transportation are major contributors[17] – and should be offered by developed nations to emerging economies at a reduced cost in order to prevent similar mistakes as those made by generations prior. Bolivia and Germany have the ideal opportunity to do just that, especially in light of the German nuclear slowdown and the rapid expansion of the Bolivian economy via nationalization of its hydrocarbon reserves. The processes of technological convergence[18] have already made a positive impact on Bolivia "such as the widespread coverage of cellular phones that vastly improved communications between regions."[19]

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[14] New Fuel Pathways
[15] Image – Global Emissions by Sector – U.S. EPA
[16] Renewable Energy Sources and Climate Change Mitigation – Summary for Policymakers and Technical Summary
[17] Global Greenhouse Gas Emissions
[18] What Is Technological Convergence
[19] Antsee, Margaret. Op-ed column.

Bolivia, Germany, & The EU

Although the development of biogas resources in Bolivia has been previously posited, the majority of these studies are limited by their scope and lack the cross-sectoral extension mechanisms such as those contained within BBDP.[20] The recommendations made by BBDP are presented in the hopes of reducing the GHG emissions of both Bolivia and Germany as well as providing economic support for the former and stimulus for the latter whilst strengthening the cultural and diplomatic relationships shared by the two governments. And while BBDP relies on German funding for its GHG-reducing technologies in addition to corporate and private grants for education and training, the exchange of academia, culture, and expertise will greatly benefit all parties involved. Furthermore, the proposal with fortify the strong cross-Atlantic bond with further exchanges in politics (e.g. the Friedrich Ebert Foundation),[21] economics (e.g. the German-Bolivian Chamber of Commerce and Industry),[22] and education through BATTS.

Due to the German government's decision to eliminate nuclear power from the national energy portfolio by 2022[23] the nation will see an increase in GHG emissions, compounded by the fact that existing renewable energy infrastructure in the North and West are not connected to the industrial sectors of the South and East,[24] due mainly to political disagreement. As such, it is necessary for Germany to promote renewable energy technologies in countries and regions where commodities like those imported by the nation are produced and exported, primarily in emerging economies. Because of Germany's current energy demands, the country imports a relatively large amount of coal even though it mines lignite or "brown coal," a major contributor to climate change, on a massive scale.[25]As such, the nation has the ecological responsibility to offset both its domestic and exported GHG emissions.

Thankfully, the promotion of renewable energy services in emerging economies by developed nations has not only been posited, but realized in Rwanda, Kenya, and beyond as the Icelandic International Development Agency has fully funded geothermal power generation capacity in several regions.[26] Moreover, the practice has already seen support in Bolivia, spurred

[20] Anaerobic Digestion of Solid Residues on the Bolivian Altiplano
[21] Friedrich Ebert Foundation
[22] German-Bolivian Chamber of Commerce and Industry
[23] German cabinet approves 2022 nuclear shutdown
[24] Nuclear Plant Closing Reflects Overhaul of Germany Energy Production
[25] Germany's dependence on imported fossil fuels
[26] The Geothermal Exploration Project

by both internal development discussions and feasibility studies[27] as well as outside parties.[28] In turn, efforts like these are supported by a bevy of governments and coalitions, including Bolivia[29] and the European Union,[30] targeting in particular biomass[31] and biofuels.[32] These steps toward reducing emissions-related pollution are necessary in cities like La Paz, where the combination of climate, aging infrastructure, population density, and topography create a precarious scenario wherein air-quality is difficult to manage and will not be remediated solely by the introduction of mass transport[33] to an area still heavily reliant on vehicles with outdated emissions controls for regulatory reasons.[34]

But the consequences of climate change are not solely the fault of Western and developed nations as "Bolivian agriculture has created some of the highest deforestation rates in the world. This has risen from almost 150,000 hectares a year during the 1990's to as much as 300,000 hectares by 2010."[35] A German-led climate change-abatement mechanism will allow for the Bolivian agricultural sector to reduce its GHG contributions by converting CH_4 to CO_2 through RNG utilization, an important step forward when considering that "officials are talking of clearing as much as 1m hectares [of land] a year." This is exacerbated by the fact that "technology is capital intensive and farmers prefer to invest their money in land[,]"[36] hence the recommendation to deploy German capital and expertise in the nation.

Furthermore, BBDP will help solidify Bolivia's welfare programming as "the government uses a welfare policy of cash-transfers and fuel subsidies to underpin growth in domestic demand, thus softening the [Socialist] model's harder side."[37] By promoting RNG utilization technologies throughout society, the government would be able to control and reduce costs as subsidies for diesel and gasoline should fall as demand for CNG transport rises. The fuel is cheaper and more powerful (i.e. higher BTU by volume) than traditional liquid fuels to both

[27] Escobar, Gabriel – DCM; Ballesteros Ferrel, Mauricio – Environment, Science, Technology and Health Specialist; del Carmen Palma, Olga – Information Specialist. U.S. Embassy, La Paz, Bolivia. 2.29.16
[28] Rebecca Larson helps bring anaerobic digester systems to Uganda, Bolivia
[29] Expression of interest to participate in the financing of the Scaling-up of Renewable Energy Program (SREP) in Low Income Countries
[30] Greenhouse Gas Mitigation in the European Union
[31] Renewable Energy – Biomass
[32] Renewable Energy – Biofuels
[33] Cable Car Over La Paz to Solve City's Urban Traffic Pollution and Congestion
[34] Status of Fuel Quality and Vehicle Emissions Standards: Latin America and the Caribbean
[35] Betting the farm
[36] Betting the farm
[37] An influence too far

produce and transport.[38] Bolivia has already seen a major increase in the private sector's rate of conversion from traditional engine types to CNG-fueled vehicles[39] in addition to government-sponsored pilot programs[40] that have generated calls for expansion.

While renewable energy proponents may argue NG may only serve as a "bridge fuel" for the foreseeable future, it provides a massive opportunity for Germany to assert its position on strengthening the EU's overarching climate goals[41] whilst bolstering the struggling EU ETS[42] – "The ETS's "cap and trade" scheme creates a limited emissions market, within which 11,000 power stations and industrial plants can buy or sell allowances [and] offset their emissions by paying for accredited emissions cuts elsewhere."[43] However, BBDP is not reliant upon the ETS as opponents of the market "have raised questions about the veracity of some of these schemes, the over-allocation of free allowances to heavy polluters, and the extent to which prices – currently hovering at around €5 a tonne – can help fuel switching."[44] While the current system does have the ability to raise prices by capping and lowering the amount of available credits, these measures "will not be enough to cut emissions to at least 80% of 1990 levels by 2050, as the EU has promised."[45] BBDP may be able to provide the precedent to spur additional international investment by other EU member nations, making this goal more achievable.

Renewable Natural Gas

The realities of renewable energy generation and importation can be unpredictable and are often prohibitively expensive.[46] Even traditional fuels carry a similar burden due to the cost of exploration as well as corruption in both the private and public sectors.[47] Even advanced, domestically-controlled sources of large-scale renewable energy such as EGS[48] are risky in the tectonically-active Andean region. Therefore, it is essential to develop clean, renewable, and reliable sources of fuel in order to ensure the greatest equitable access to energy as well as

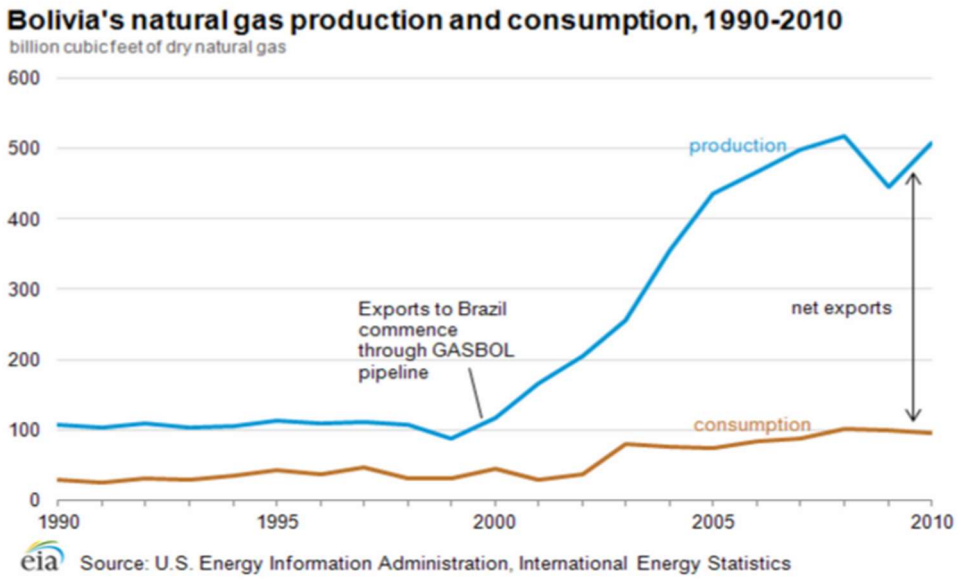
[38] Energy Price Spread: Natural Gas vs. Crude Oil in the US
[39] Bolivia: over 27,000 vehicles where converted to natural gas in 2014
[40] Bolivian Government Supplies 200 CNG Engines for Santa Cruz Buses
[41] EU 2030 Goals
[42] The EU Emissions Trading System (EU ETS)
[43] EU set to emit 2bn tonnes more CO2 than Paris climate pledge
[44] EU set to emit 2bn tonnes more CO2 than Paris climate pledge
[45] EU set to emit 2bn tonnes more CO2 than Paris climate pledge
[46] The truth behind Costa Rica's renewable energy
[47] Brazil's Petrobras Reports $17 Billion in Asset and Corruption Charges
[48] How an Enhanced Geothermal System Works

maximize the value of energy-related exports.[49] These points become more salient following the conclusion November's COP21 when considering the fact that the European Union is already on track "to emit 2bn tonnes more CO2 than it promised at the Paris climate talks, threatening an agreement to cap global warming"[50] at two degrees Celsius.

More recently, clean and sustainable energy sources such as solar PV and wind have become more affordable as the cost of materials and construction have dropped dramatically, due in part to massive investments promoted by the German and Chinese governments.[51] The technologies that combine to make RNG – AD[52] and biogas capture, fuel upgrading facilities, CNG delivery units, storage tanks, and pipeline injection installations – have followed a similar downward trend in component cost.[53] The price of biogas-generated electricity delivered in the United States (where end-use prices are higher than those in Bolivia due to regulatory requirements and lack of subsidization) varies with feedstock composition, but averages roughly $0.10 to $0.20/kWh,[54] comparable to and competitive with that of offshore wind ($0.20/kWH) and solar PV ($0.125/kWh).[55]

Bolivia's economic backbone is fossil fuel production, particularly NG which comprises roughly 45% of total national exports, skyrocketing past the considerable growth of domestic consumption in recent years:[56]

[49] Brazil Increases Natural Gas Imports from Bolivia to Restart Power Plant
[50] EU set to emit 2bn tonnes more CO2 than Paris climate pledge
[51] Global Trends in Renewable Energy Investment 2015
[52] Anaerobic Digestion – Case Studies
[53] How Much Renewable Natural Gas Can Be Produced
[54] An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities
[55] Solar Electricity Cost
[56] What's Driving Bolivia's Booming Economy?



[57]

"Bolivia has trumpeted the success of increasing both gas exports and domestic consumption."[58]

Given the recent depression in oil prices,[59] the net volume of CH_4 and petroleum exports must be maximized in order to maintain profits margins and economic growth. Projections for the oil and gas industry in the coming decades,[60] coupled with current[61] and projected[62] instability of the commodity, show that nations relying on fossil fuel resources for export and/or import are in danger of rapid price fluctuations, especially those locked-in to long-term contracts;[63] a point to consider should "Bolivia prove [to be] an unreliable gas supplier for partners such as Brazil, it may bring more competition upon itself in the shape of LNG imports."[64] Bolivia's lack of ports – the nation lost its access to the Pacific Ocean in a war with Chile in 1884[65] – contributes greatly to lost profits as neighboring nations often levy large fees for utilizing their pipeline network.

Just as important as the economic benefits of RNG are the fuels GHG emissions-reducing capabilities. The composition of the fuel is nearly identical to that of traditional NG, but offers up to a twenty-five times greater GHG abatement by replacing CH_4 with CO_2.[66] Due to this

[57] Image – Bolivian Natural Gas Production & Consumption – U.S. EIA
[58] Power to the people
[59] Oil price rout sends inflation to lowest levels witnessed since Great Depression
[60] Energy Outlook 2035
[61] World Energy Outlook 2015 – Executive Summary
[62] International Energy Outlook – Overview
[63] Bad Things Happen in the Dark
[64] Power to the people
[65] Chile and Bolivia are still arguing over the outcome of a war they fought 131 years ago
[66] Renewable Natural Gas – Clean Green Energy

conversion of fugitive gases to usable energy, the carbon intensity biogas derived from food and related wastes is -15g/MJ compared to that of 99.18g/MJ for gasoline and 68g/MJ for diesel.[67] Beyond easily replacing coal as a source of electrical energy, "biogas provides the lowest carbon fuels – or transportation of any kind – currently available" while captured agricultural, landfill,[68] and wastewater gases[69] offer a minimal carbon intensity ranging from ~8g/MJ to ~15g/MG – even EVs have a 30.80g/MJ impact.[70]

Scaling-up these savings could bring massive reductions to Bolivian and German GHG emissions as in the state of California the full utilization of wastewater treatment gases, alone, could reduce its CO_2 impact by 3MMT, annually.[71] BBDP will allow Bolivia to further strengthen its control of NG revenue without exposing itself to international market fluctuations after experiencing serious tensions with major international actors during the 2006 nationalization of the oil and gas operations in the country.[72] Given the German investment in the initial development of BBDP, maintaining and expanding RNG capacity would represent a minimal portion of YPFB's annual operating budget as "construction of the Gran Chaco natural gas liquids separation plant cost $700m[,]"[73] alone. This is to say nothing of the nation's need to bolster exploration efforts in the face of dwindling reserves and RNG represents a way for Bolivia "to maintain and expand gas production. Contrary to government confidence, some analysts and industry insiders expect production to start falling soon from its current level of about 60m cubic metres a day."[74]

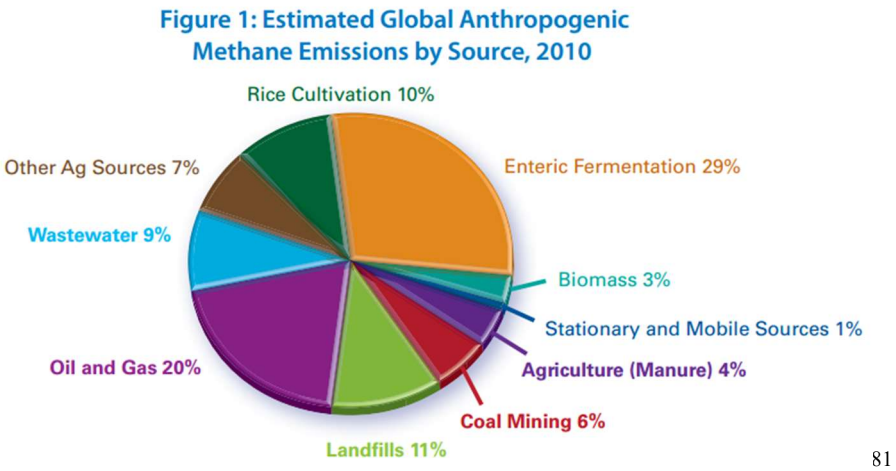
Moreover, while "technologies for anaerobic digestion and biogas clean-up are maturing and evolving[,]"[75] the challenges posed by RNG utilization are minimal in comparison to YPFB's overarching energy goals[76] and would help the company reduce its carbon footprint in a "well-to-wheels" scenario.[77] Lastly, the cost of the proposed installations can exceed repayment

[67] Why California Needs A Renewable Fuel Gas Standard
[68] Landfill Gas Power Plants
[69] Saving the World, One Sewage Treatment Plant at a Time
[70] Why California Needs A Renewable Fuel Gas Standard
[71] Why California Needs A Renewable Fuel Gas Standard
[72] Bolivia's Nationalization of Oil and Gas
[73] Power to the people
[74] Power to the people
[75] Renewable Natural Gas for Transportation: An Overview of the Feedstock Capacity, Economics, and GHG Emission Reduction Benefits of RNG as a Low-Carbon Fuel
[76] Power to the people
[77] Full Fuel Cycle Assessment: Well-to-Wheels Energy Inputs, Emissions, and Water Impacts

in their combination of fuel produced and GHG emissions reductions generated by the nation's potential feedstock capacity.[78] And by encouraging various sectors to participate in BBDP, the Bolivian government will have created a system wherein the initial cohort of German advisors and technicians can share their expertise through BATTS.[79]

This process would mimic the formative days of the El Ceibo Chocolate Company which could create a culture of education and inclusion around the nation's energy sector through RNG. And while the proposal recognizes the ramifications of "white elephant" projects and their implication for development in Bolivia, BBDP's sustainability is not singularly reliant upon either of the nation's involved nor the ETS for funding nor the education and training of a new workforce through BATTS. Lastly, YBFB's history of cooperation with other nations and international energy firms is lengthy and has proven successful in exploiting hydrocarbon resources throughout Bolivia,[80] providing a model for BBDP to follow.

By economizing waste streams, Bolivia and Germany stand to reduce their contributions to climate change in nearly every sector.



[81]

[78] Renewable Natural Gas for Transportation: An Overview of the Feedstock Capacity, Economics, and GHG Emission Reduction Benefits of RNG as a Low-Carbon Fuel
[79] Energy 101: Promoting Energy Education in the Nation's Colleges and Universities
[80] Bolivia's YPFB: $3 bn invested in exploration projects
[81] Image – Global Methane Emissions – GlobalMethane.org

3. Climate Change-Abating Development

Challenging the post-development theories posited by Arturo Escobar in ED

Introduction

As of this writing, anthropologist Arturo Escobar's influential book is entering its 21st year of circulation and remains a seminal text in the development world; however, much has changed in Colombia (ED's primary focus), Bolivia, and the rest of the world in the interim. The gap between the poor and the wealthy has widened in nearly every nation,[82] demonstrating a growing need for the redistribution of capital, knowledge, and technology to fight threats to humankind's wellbeing such as climate change – especially in emerging economies relying on natural resources for basic survival. Given the relatively new constitutional Law of Mother Earth,[83] Bolivia stands to set a higher global standard in this practice by developing sustainable domestic economic and environmental protections. As the nation reimagines its development practices, international assistance in the matter could be of great benefit.

More specifically, the development paths taken by Bolivia and Colombia stand apart as Colombia has developed strong international and commercial relationships since the demise of Pablo Escobar[84] while the Bolivian government has spent a good portion of Evo Morales' ten years in office taking measures to fight the encroachment of multinational corporations upon culture and the economy. This process of decolonization,[85] namely in the agricultural and energy sectors, has "helped to foster the environmental movement [such as] the protection of rainforests and animals."[86] Bolivians are adamant about the protection of Pachamama (Mother Earth), spurred by Bolivia's large indigenous population,[87] whilst self-developing its economy and natural resources in a sustainable manner.[88]

De-Growth & Post-Development

The primary detractor to Escobar's claims are temporal in nature (i.e. the fact that ED was published in 1995), although he belongs to a much larger school of post-development theory that has since evolved and incorporated some aspects of the sustainable discourse.[89] However,

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[82] Global Inequality
[83] Law of Mother Earth – The Rights of Our Planet – A Vision from Bolivia
[84] The Effects of the Drug Cartels on Medellin and the Colombian State
[85] Globalization and the Decolonial Option
[86] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[87] Survival instincts
[88] Indigenous Power: Renewable electricity and sustainability in Mexico and South America
[89] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16

observers go farther in citing the literature as being "too narrow in its scope" and claim Escobar wants "the best of both worlds"[90] when he calls for the maintenance of "new practices of vision and knowledge, even if these resistances take place within the modes of the development discourse."[91] Escobar demands extreme ecological protections as well as economic and social equality without the processes of development taking place – a seemingly impossible feat in a nation that demands decolonization as well as poverty alleviation and environmental conservation.

While BBDP agrees that "conventional development" would be a detriment for the nation, it does not maintain the sentiment that all forms of development are "colonialist"[92] in nature as there are several discourses which push back against such practices both outright and in prioritizing self-development, environmental protection, and sustainability,[93] even when assisted by other cultures or nations. Escobar's dichotomous argument is evident as early as ED's preface when he acknowledges the progress of societies in the inclusion of peasants, women, and the environment in political activities but does not extend the same recognition to advancements in sustainable economic growth whilst lamenting the apparent unmaking of the Third World.

The failures of traditional practices in several emerging economies is not as a simple as Escobar states due to "the increasing opposition to [development] by popular groups in the Third World."[94] He further complicates the possibility of interdisciplinary collaboration by prioritizing "local constructions" and stating one must "focus on popular groups' forms of resistance to the introduction of capitalist practices[,]"[95] thereby preventing the elevation of the local discourse to broader venues of public discourse. However, recommendations such as this are "too categorical" as "blanket prescriptions"[96] are generally counter-productive even to de-growth practices. Escobar's rebuke of a then-new discourse of development alternatives is highlighted in ED's conclusion when he cites the need for alternatives to development that prioritize "1. local culture & knowledge; 2. critical of science; 3. localized, pluralistic grassroots movements."[97]

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[90] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[91] Escobar – Page 155
[92] Escobar – Page 9
[93] The Whole-School Approach to Education for Sustainable Development: From Pilot Projects to Systemic Change
[94] Escobar – Page 4
[95] Escobar – Page 95
[96] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[97] Escobar – Page 214

What's troubling about this is that conclusions similar to this drawn throughout ED "do not allow for" the existence or inclusion of "beneficial or positive development."[98] It is essential to note that unlike with theories, the negative effects of actions within a given environment and/or ecosystem can be defined, measured, and remediated with the implementation of solutions[99] such as those recommended by BBDP. Unfortunately, the developmental (in)actions of one nation – regardless of its intention and governmental structure – can have detrimental effects on countries on the opposite side of the world.[100] So while the de-growth approach to development may result in temporary positive gains for a given nation, the negative effects of development practices taken by any other combination of countries may prove insurmountable, over time.

Bolivia has recently seen a dramatic spike in per capita GDP, contributing to a halving of the socialist nation's poverty rate through "a welfare policy of cash-transfers and fuel subsidies to underpin growth in domestic demand, thus softening the model's harder side."[101] This structure provides a unique opportunity for the rapid development of sustainability programs in a variety of sectors. By providing adequate economic support as well as legal protection for sustainable development in the nation whilst continuing its decolonization efforts along the way, the Bolivian government could prove incorrect several key elements of Escobar's rebuke of development models made within his interpretation and application of the de-growth discourse.[102]

Sustainable Development

"Mother Earth is considered sacred, from the worldviews of nations and peasant indigenous peoples."[103]

At the time of ED's publication, the four main aspects of the school of sustainable development as described by Escobar [104] were in their formative days and have since been extrapolated to include a holistic[105] approach to living beyond resource consumption.[106] BBDP is

[98] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[99] Escobar – Page 155
[100] Global warming: China's contribution to climate change
[101] An influence too far
[102] Escobar – Preface
[103] Law of Mother Earth – The Rights of Our Planet – A Vision from Bolivia
[104] Escobar – Pages 194 & 195
[105] Escobar – Page 90
[106] The Four System Conditions of a Sustainable Society

centered on a foundation of acknowledging the imperfections of the world as a whole to maximize productivity by rejecting the reliance upon perfectly predictable resources as a given.[107] What's more, it can take generations to codify and/or reform a given social construct that appears to be self-evident to the casual observer, such as those of climate change acceptance, gender equality, and racial tolerance in the United States. So while the effects of the sustainable development discourse are yet to be realized climatically – but are more than evident technologically – they should not be wholly dismissed.

BBDP recognizes that "there are a lot of complexities" involved in development and a wide amount of "viable alternatives"[108] which can satisfy Bolivians of all walks seeking to advance society, in one way or another. This point should be of great import to observers such as Escobar as the decoupling of national GDP from GHG emissions[109] has proven that sustainable development is possible using the best available practices. This process will only continue to accelerate the remediation of previous climate and environmental degradation as technologies such as those contained in BBDP and their analogues advance, accordingly.[110] As such, BBDP recommends a hybridized model[111] of technical development incorporating traditional methods of communication between humanity and Pachamama.

And while Escobar's interpretation of development in 1995 is both relevant and necessary for the continued understanding of the perils of traditional development, it is also incorrect in its conclusion that sustainable development is "self-destructing and being unmade by social action, even as it continues to destroy people and nature. The dialectic here tends to push for another round of solutions, even if conceived through more radical categories – cultural, ecological, politicoeconomic, and so on[.]"[112] Ultimately, development is not a binary practice, rather it occurs on a broad spectrum where one observer's calculations of a given project may be that of inadequacy while another's assessment may be that of extreme over-development, as was the case with Escobar's view of the UN's FNPP. Escobar cites Talal Asad's claim that

[107] Escobar – Page 66
[108] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[109] Decoupling of global emissions and economic growth confirmed
[110] 50 Years of Moore's Law
[111] Escobar – Page 51
[112] Escobar – Page 217

anthropologists are hesitant to question ""the power structure within which their discipline has taken shape""[113] whilst pointing the reader in the direction of colonialism and neocolonialism.

While one is inclined to believe that human nature dictates the preservation of these systems of dominion, modern anthropologists face a much larger obstacle in examining the ongoing development of cultures practicing methods of decolonization. BBDP also places a priority on environmental protection over that of growth economics[114] so that Bolivia can regain trust in its stance on environmental protection as "controversially, the prospect of drilling in protected landscapes has been raised. That has sparked unease among environmentalists previously sympathetic to Morales' administration[.]"[115] But the need for growing Bolivian NG reserves is great as they were "adjusted down dramatically about six years ago on technical grounds," with "roughly 10.5tn cubic feet"[116] remaining. Given the instability of global NG prices coupled with global increases in NG consumption,[117] the importance of RNG reliance should be evident to analysts and environmentalists, alike.

Escobar states that "[u]nderdevelopment became the subject of political technologies that sought to erase it from the face of the earth but it ended up, instead, multiplying it to infinity."[118] This type of language is dangerous as it not only disregards any health related benefits of development, but seemingly bars the application of the sustainable development discourse from proffering solutions to preexisting problems. BBDP loans will not have to be repaid by the Bolivian government as they are solely receiving technology and expertise,[119] avoiding the perils of nonpayment of World Bank, IMF,[120] or other international financial loan obligations[121] such as using "the foreign-exchange earned from exports to pay off loans (more often than not, center countries levied high tariffs against Third World products)[.]"[122] In "solving the problem of a given case,"[123] the GIZ will work with private sector companies to "take responsibility for the

[113] Escobar – Page 14
[114] Escobar – Page 195
[115] Power to the people
[116] Power to the people
[117] Global natural gas consumption doubled from 1980 to 2010
[118] Escobar – Page 52
[119] Escobar – Page 87
[120] Bolivian Independence from the World Bank and IMF
[121] Escobar – Page 172
[122] Escobar – Page 82
[123] Escobar – Page 110

plan's implementation"[124] whilst Bolivian institutions will handle "[h]ow the new policy and accompanying technologies are decided upon[.]"[125]

Energy Production

In addition to its GHG-reducing capabilities, RNG utilization may also prevent YPFB from profitably exploring for gas reserves via fracking.[126] Thankfully, the practice is not currently in taking place in Bolivia, although it has been discussed by YPFB's directors and among regulatory circles.[127] Unconventional NG exploration carries wildly unpredictable costs, but even relatively optimistic estimates peg them at around $500/1000m^3$ in developed nations.[128] When given the current market prices for oil and NG, the survival of even the most advanced exploration operations on the planet are in question – "many sources put the average break even point for a fracked horizontal well above $60 a barrel with the higher-cost wells coming in at over $90 a barrel."[129] "The average cost per well was calculated at $2.38 million, of which around a quarter is directly related to the fracking process itself."[130] Considering the low cost-per-volume of NG coupled with Bolivia's 75/25 composition of NG-to-oil reserves, fracking for NG becomes even more uneconomical.[131]

Market forces, which Escobar tends to rebuke, may finally be able to align with the beliefs of environmentalists. The limitations of relying on RNG for fracking prevention would be linked to the scalability of the chosen AD technology as not all installations behave in the same manner as most have not yet existed long enough to prove their ability to maintain output levels indefinitely. However, as RNG production does not require geological exploration, it does not contain any of the harmful chemicals used in fracking,[132] nor does it create topographical instability. Considering the numerous calamitous possible outcomes that could arise from fracking near high-altitude populations and low-lying areas,[133] preventing oil and gas exploration via fracking methods is essential. BBDP could prevent its economic viability in providing

[124] Escobar – Page 111
[125] Escobar – Page 122
[126] Is Bolivia going to frack 'Mother Earth'?
[127] Escobar, Gabriel – DCM; Ballesteros Ferrel, Mauricio – Environment, Science, Technology and Health Specialist; del Carmen Palma, Olga – Information Specialist. U.S. Embassy, La Paz, Bolivia. 2.29.16
[128] The Economics of Unconventional Gas Extraction Projects
[129] The Cost of Shale Oil Versus Conventional Oil
[130] Fracking – A Bubble Waiting to Burst?
[131] Power to the people
[132] What Chemicals Are Used
[133] Mounting evidence says injection wells cause Oklahoma's earthquake surge

upgraded biogas as in Ontario, Canada, where RNG is incorporated into pipeline delivery and the average cost of NG to the consumer is ~$380/1000m^3.[134]

The sharing of information and wealth must be incorporated into Bolivia's brand of sustainable development if it wishes to maintain its historic economic growth and diversification, especially when considering "that the nationalisation left the government "take" from some gas fields at 82 per cent, Bolivia has not been good at incetivising foreign investment."[135] Therefore, BBDP suggests that the defense of development should not be codified in legislation, policies, and/or regulations supported solely by those in favor of its traditional forms such as the military. Instead, it recommends that those who believe the process can be reformed in-motion as it attempts to remediate the damage done by predecessors such as consortiums of farmers, laborers, and miners, much like those who stood to eradicate governmental and judicial corruption.[136]

RNG utilization could reduce Bolivian and German GHG emissions by up to 25 times of what would have occurred otherwise through the release of CO_2 in the place of CH_4[137] as they will not be reduced immediately following the nuclear shutdown in 2022 for two main reasons. Although renewable energy sources are, operationally speaking, GHG-free, they require significant energy inputs for their construction and have much shorter lifespans than nuclear power stations.[138] Compounding this is the fact that many power providers have opted to reopen shuttered fossil fuel-burning facilities or constructed new NG-fired plants as fuel prices are at a historic low.[139] But these prices have not deterred President Morales's cabinet as it has authorized "oil exploration in the country's protected areas, unafraid to clash with an environmental NGO that supported [the president] when he was the leader of the opposition in Congress, a decade ago."[140]

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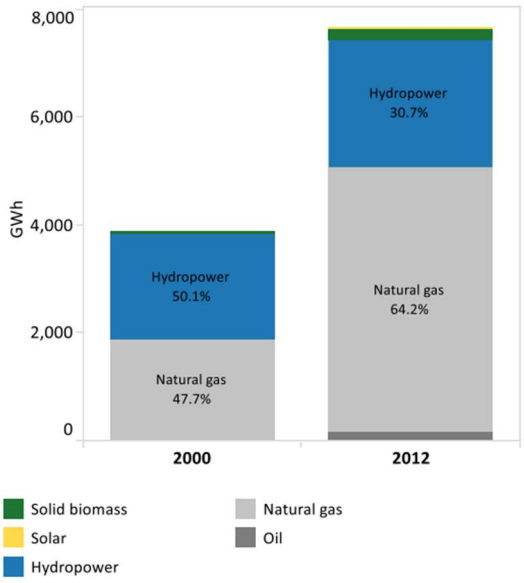
[134] The cost of energy: a comparison of fuels in Ontario
[135] Power to the people
[136] Overview of corruption and anti-corruption in Bolivia
[137] Radiative Forcing of Climate
[138] Nuclear Power Versus Renewable Energy – A Trend Analysis
[139] Why Germany's Nuclear Phaseout is Leading to More Coal Burning
[140] An influence too far



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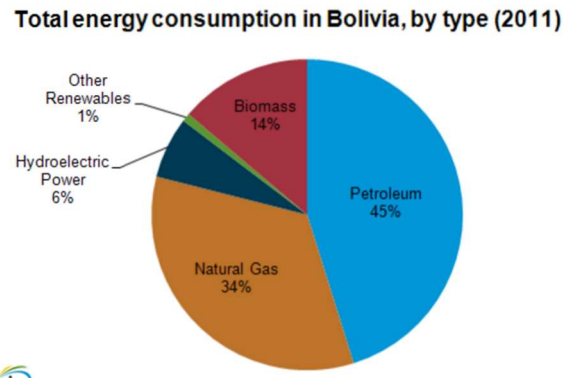

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Bolivia has the opportunity to reshape its electrical generation portfolio, which has seen increases in its share of natural gas and decreases in renewable energy, by diversifying its energy consumption profile.

Unfortunately, in nationalizing the majority of industry in the country, foreign investment has been deterred from (re)investing in the nation – Sumimoto remains as the only major multinational corporation working in the nation's commodities sector.[143] YPFB stands as the sole oil and gas company exploring and producing hydrocarbon resources in the nation. However, there is a desire for "foreign companies to take part in the drive to lift reserves to 11.5tcf in 2021 and 18tcf in 2025. These figures include the depletion of existing reserves[,]" an important note to consider while YPFB now relies heavily on international oil and gas conglomerates for assistance in exploring for new fossil fuel resources.[144] A decrease in GDP will not be welcomed warmly by the Bolivian population, regardless of the discourse chosen by the government.

[141] Image – Bolivian Electricity Generation – IRENA
[142] Image – Bolivian Energy Consumption – U.S. EIA
[143] Kings of the hill
[144] YPFB y Petrobras firmaran un convenio

Holistic Agricultural Production

"With soya alone representing Bolivia's third-biggest source of foreign exchange after gas and mining, the government has announced ambitious plans to boost the area of land under cultivation from 2.7m hectares last year to 4.5m hectares by 2020."[145]

A major component of Escobar's anti-capitalist agricultural argument is outlined when he cites the promotion of "fertilizers, pesticides, and improved seeds"[146] (i.e. GMO) through FNPP in Colombia to the benefit of multi-national corporations. BBDP recognizes the threat that analogous programs pose to fragile ecosystems – from soil exhaustion to land-use change, non-traditional agricultural practices have taken a toll on the viability of arable land around the world.[147] BBDP aims to prevent and/or curtail similar practices in Bolivia through the production of natural, organic fertilizers generated during AD for agricultural use. BBDP agrees with Escobar regarding the mechanization of genomes for economic benefit in supporting "restrictions on the use of biotechnology"[148] as RNG installations could easily incorporate animal waste (i.e. manure) from llamas and guinea pigs[149] to produce soil enhancers, thereby eliminating the necessity for reliance on chemical products introduced during "the Green Revolution"[150] that decrease the viability of fertile land.[151]

What's more is that recent research has shown that the improvement of soil may not only increase production yields but help to store additional CO_2, as well;[152] however, Bolivia has already begun construction on "[a]n ammonia and urea plant to make fertilizer[…] in an $877m investment."[153] These plans should be seen as issues of great concern for both agricultural producers and environmentalists as Santa Cruz's president of the soya producers' business chamber, Reinaldo Diaz, has dubbed those opposed to GMOs as "brainwashed." He continues by saying that "[w]ithout biotechnology, it makes it very difficult to compete with our neighbours," appealing to the economically-minded farmers of the eastern lowlands.[154] This process will ultimately damage Bolivia's case for "organic" value-added products, which could bring in

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[145] Betting the farm
[146] Escobar – Page 128
[147] Genetically Engineered Crops – A Threat to Soil Fertility?
[148] Betting the farm
[149] Psychrophilic anaerobic digestion of guinea pig manure in low-cost tubular digesters at high altitude
[150] Escobar – Page 117
[151] Economic Feasibility Assessment for Renewable Fertilizers from Anaerobic Digestion with Integrated Manure Nutrient Recovery System
[152] Agriculture – Cool The Planet. Feed The World.
[153] Power to the people
[154] Betting the farm

revenues as high, if not higher, than massive quantities of GMO crops.[155] The proposal disagrees, however, that sustainable development systems are inherently damaging, ecologically, with the examples of sustainable agricultural[156] and industrial practices[157] increasing rapidly throughout the world.

The prevention of drastic land-use change is extremely important to the survival of aerial, aquatic, and terrestrial ecosystems, but we are not witnessing nature's "symbolic death" as more recent generations coming into power have placed the utmost import on the conservation and preservation of nature.[158] And with its introduction of the SDGs,[159] the UN has codified the need for environmental protection and remediation efforts in all nations, regardless of respective economic development levels. Bolivia has the ability to contribute to these efforts with its great potential "for the management of grass as an AD feedstock to be recognised under agri-environment schemes" given its vast land resources, thus contributing to the nation's "landscape diversity and biodiversity."[160] The benefits of AD for agricultural production include:

- Reduced weed and disease burden
- Greater availability and topsoil penetration of nitrogen
- Additional soil carbon sinks arising from the supplement with crop feedstocks
- Reduced leaching leading to better availability of nutrients[161]

The capacity for environmental remediation through sustainable development practices generates similar results to Escobar's de-growth models without the economic burden of market-throttling. And while the sustainable development discourse imitates its predecessors in operating as "a practice, with conditions, rules, and historical transformations[,]"[162] it does so while countering many of development's historical prescriptions through traditional methods already in-place. Moreover, innovative agricultural practices such as "using wildflower borders and wildflowers grown as part of an environmental scheme as feedstock"[163] would be easily implementable in a nation as sparsely populated as Bolivia.

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[155] Organic farming offers higher profits with challenges
[156] 10 Urban Farming Projects in New York City
[157] Kalundborg Symbiosis is the world's first working industrial symbiosis
[158] Fostering Industrial Symbiosis for Regional Sustainable Development Outcomes
[159] Sustainable Development Goals
[160] The Case for Crop Feedstocks in Anaerobic Digestion
[161] The Case for Crop Feedstocks in Anaerobic Digestion
[162] Escobar – Page 216
[163] The Case for Crop Feedstocks in Anaerobic Digestion

This supplements one area of particular concern for BBDP, standing in accordance with Escobar's recommendations – discouraging monoculture agri-practices such as the encroachment of coca production on protected areas like the TIPNIS.[164] These delicate ecosystems must be protected from development, and one way of doing so is to promote the diversification of agricultural production in currently unused or underutilized lands. "Thomas Killeen, an environmental scientist, argues that Bolivia could increase its agricultural production dramatically "without cutting down a single tree"[…] The country could easily double or triple production with no further deforestation if producers adopted modern water management while expanding crops to underutilised pastures[.]"[165]

In growing quinoa alongside corn and soya with grass and wildflower borders, topsoil can remain fertile for much longer, bringing increased production yields, as well.[166] But governmental incentivization[167] is necessary to stimulate the rural Bolivian agricultural base as "technology is capital intensive and farmers prefer to invest their money in land."[168] BBDP posits that RNG production will result in land-use diversification as farmers will no longer have to consider producing a singular "cash crop" for the marketplace[169] as nearly all byproducts are fit for AD. Moreover, the market for organic Bolivian quinoa has already been established as "people from New York to London pay roughly $10 a pound for it[…] The U.S. imports 60 per cent of Bolivia's quinoa production; the rest goes mostly to Europe[,]" climbing from "4,900 tonnes in 2005 to 35,000 tons in 2013[.]"[170]

This has been a tremendously powerful force in aiding indigenous Bolivian farmers from escaping the "poverty" Escobar claims was invented by developed nations as "[t]he price paid to Bolivian producers per kilo of organic royal quinoa" rose "from under $1 in 2007 to almost $5 last year."[171] The integration of indigenous agricultural practices,[172] as recommended by the Law of Mother Earth, such as crop rotation in high-altitude areas could provide for an even more profitable export industry. These practices could be expanded to "marginal and idle land" found

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[164] TIPNIS: mas que un conflicto por una carretera
[165] Betting the farm
[166] Betting the farm
[167] Renewable Natural Gas Helps Reduce Emissions, Policy Support Needed
[168] Betting the farm
[169] Escobar – Page 172
[170] Quinoa – Ancient superfood, modern success
[171] Quinoa – Ancient superfood, modern success
[172] Escobar – Page 166

throughout Bolivia, the "result of degraded soil quality, [which] remain largely unused for any agricultural purposes;" these lands also "have the potential to supplement or supply grass silage for AD without displacing any arable land used for food production[.]"[173] The promotion of these practices can take place swiftly as Bolivian "institutions do not necessarily work in a capitalist way – you must start from zero."[174] And unlike FNPP, BBDP does not promote the alteration of domestic food production or consumption.[175]

But Bolivian expansion has come at a price in the form of deforestation, "in marked contrast with the leftwing government's environmental rhetoric."[176] For a nation that places a tremendous value on Pachamama, this is troubling considering the available alternatives. RNG utilization could help to "reduce GHG emissions from wildfire by 65 percent or more[,]"[177] in some cases, which would be of great benefit to the conservation and protection efforts in the lowland Amazonian and TIPNIS regions. Lastly, an RNG marketplace may disincentivize the cultivation of crops as a feedstock for biofuel, a process which "well-to-wheels" analyses have proved to be more damaging to the environment than traditionally fuel production.[178] This is an important note for Bolivians to consider as "the government claims that only 10% of the country has been explored for hydrocarbon resources."[179]

Conclusions

When compared, Bolivia and Germany have relatively different cultures, histories, and economies but have cooperated for many years. BBDP presents yet another avenue for the countries to come together through commonalities (i.e. agriculture and NG consumption for energy and transportation) to develop climate change-abating systems and technologies through their respective regimes of representation.[180] In addition to operationalizing many elements of sustainable development, BBDP also provides an avenue for the satisfaction of all four pillars of

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[173] The Case for Crop Feedstocks in Anaerobic Digestion
[174] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[175] Escobar – Pages 112 & 113
[176] Betting the farm
[177] Why California Needs A Renewable Fuel Gas Standard
[178] Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcanes, and cellulosic biomass for US use
[179] Bolivia – Background – U.S. Energy Information Agency
[180] Escobar – Page 10

CSR – environmental, economic, social, and civic duty.[181] In this regard, BBDP recognizes the necessity for including several of Escobar's recommendations contained in ED in regards to the temperance of international corporate exposure.

His critiques of economic assistance as a necessity in the Third World, in addition to the dominion of cultures and the demolition of tradition in the processes of development, are generally correct. They are lacking, however, a positive application wherein climate, culture, and international relationships – both diplomatic and economic – can be healed and reformed to create new regimes of representation. As such, BBDP targets "situations and people other than those provided by the [traditional] development discourse"[182] by rejecting the "peasant model"[183] and taking a bio-centric approach to development by placing an economic value on ecological conservation[184] whilst maintaining a hybridized focus on both long-term GHG emissions reductions in addition to short-term economic benefits.

BBDP can accomplish the goals set forth by Escobar when he calls for "[t]he investigation of alternative representations and practices in concrete local settings, particularly as they exist in contexts of hybridization, collective action, and political mobilization."[185] The proposed international cooperation can result GHG emissions reductions for both nations as well as a vibrant exchange of cultures. BBDP rejects the FNPP-esque methods of studying and solving a "problem"[186] and funding value-extracting products without replacing the capital necessary for future self-development through an environmentally-conscious discourse. In all, the strategies recommended by BBDP stand in accordance with many of the tenets of Escobar's book, and do so in a profitable and sustainable fashion.

"I concluded that the struggle over representation and cultural affirmation must be carried out in conjunction with the struggle against the exploitation of and domination over the conditions of local, regional, national, and global political economics. The two projects are, indeed, one and the same."[187]

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[181] Government Banking – New Perspectives on Sustainable Development and Social Inclusion from Europe and South America
[182] Escobar – Page 12
[183] Escobar – Page 96
[184] Economics of Environmental Conservation
[185] Escobar – Page 19
[186] Escobar – Page 117
[187] Escobar – Page 170

Unfortunately for the supporters of the post-development discourse like Escobar,[188] traditional practices like slash-and-burn agriculture[189] must be discontinued as the planet can no longer sustain the damage it causes. And while a given development discourse can effect entire populations upon implementation, only a select few may realistically understand the discussion and participate in the debate of its merits.[190] I must applaud Escobar for his inclusion of Marx's refusal to include technology as an "exogenous variable" as compared to the constants of "natural resources and institutions" in relation to the equation of "changes in capital and labor productivity[.]"[191] In citing Marx's applications of surplus value over absolute surplus, Escobar has highlighted a turning point wherein waste can and should transition from a logistics necessity to a production necessity[192] to the benefit of all.

The "ongoing dialogue between all living beings" is represented in BBDP by the desire to provide equitable access to sustainable energy and healthy food in all their forms for Bolivians whilst respecting the environment, just as each farm "for instance, demands different cultivation routines, different practices of caring."[193] And much like BBDP, several economists have challenged "tenets of orthodox economic theory (particularly the theory of international trade)[…] which included structural considerations, and showed greater concern for the standard of living of the masses."[194] The de-growth discourse posits that "[t]he euphoric mood the boom of the 1920's created turned somber" [195] in regards to the failures of development, but this does not mean that the practice of should be discarded, entirely. The process has proven to be able to reverse the damage done by previous generations and sustainable development should be seen as a tool for decolonization as well as integration in the world.[196] Escobar's assertion that technology is not "neutral" must be taken advantage of to uplift and affect positive change, not to be used "as an instrument for the creation of cultural and social orders."[197]

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[188] Escobar – Page 204
[189] Escobar – Page 131
[190] Escobar – Page 218
[191] Escobar – Page 63
[192] Escobar – Pages 60 & 61
[193] Escobar – Page 169
[194] Escobar – Page 81
[195] Escobar – Page 71
[196] Escobar – Pages 43 & 44
[197] Escobar – Page 36

4. Case Study

The El Ceibo Chocolate Company

The case study for BBDP serves as a pilot project for Bolivian RNG and focusses on the El Ceibo Chocolate Company[198] for AD of agricultural and production-related wastes, fuel upgrading, onsite electricity generation and waste heat utilization.[199] Following successful operations at El Ceibo, BBDP is to be expanded to nearby restaurants, farms, and similar cooperatives to power the vehicles they operate, for onsite or distributed energy generation, and for the production of organic fertilizers. Benefitting from the successful demonstration of and data generated by BBDP installations in El Alto and La Paz, RNG utilization via pipeline injection can take place throughout the nation. The cooperative is of great interest to the proposal for several reasons, primarily due to its history of cooperation with the German government and volunteers from the nation in providing both financial and technical assistance to El Ceibo.[200]

"[C]limate change adaptation is becoming increasingly important and is being incorporated into existing projects in the priority areas of agriculture and water."[201]

Headquartered above its production facilities in El Alto, El Ceibo is a model cooperative mirroring somewhat the nation's governmental structure of shared management, wealth, and indigenous inclusion – its organization also mimics traditional Andean cacao cultivation practices in that members rotate from the factory to management to the fields and beyond.[202] El Ceibo began as a "very crude operation," but knew early on they wanted to expand and produce "value added products," starting with "small balls of chocolate, like candy."[203] Prof. Kevin Healy of Georgetown University cites the company as an "important case because it shows how you can have development with traditional cultural norms."

While member farmers of the cooperative are often situated close to one another, they are some distance from the production facility, thereby making transport of cacao to the factory in El

[198] El Ceibo Chocolate Company
[199] Combined heat and power (CHP) plants
[200] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[201] Bolivia – Situation and Cooperation
[202] Apaza, Bernardo; Pacara C., Hoved; Sandoval M., Felipe. Management team – El Ceibo Chocolate Company – La Paz, Bolivia. January 10th, 2015.
[203] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16

Alto a difficult and expensive proposition.[204] Moreover, when the cooperative brought in large trucks "at a very low price" in order to "break down the middle man,"[205] it could not compete because it did not yet possess the proper skillset for rapid production and distribution amplification. El Ceibo went back to a smaller method of transport for the La Paz district. BATTS would be able to impart the marketing expertise necessary for the successful introduction of more advanced production and transport technologies.

"It hasn't been an easy ride and they've had a lot of support."[206]

El Ceibo was chosen as the pilot for expansion because of its longstanding relationship with Germany as the government helped to get the cacao producer off its feet – technically qualified Germans, Brits, Swiss, and others volunteered vital assistance to help manage early-on as markets emerged in the late '80's.[207] "German technical assistance was even more important" than luck "as it was sustained and precise[,]"[208] fostering capacity increases that lead to international distribution. And while development is "more complicated in the city because of critical zoning issues," the planning and construction of BBDP facilities could help El Ceibo repair its relationship with the local government following recent "troubles" with the municipal government after it proposed "shaving property" to build a larger roadway and for other transportation projects.[209]

The factory is an ideal location for the AD of organic waste because such facilities are "(falsely) often perceived as a poor neighbour" but operate most efficiently when "close to markets for digestate" while producers are generally "just as willing to build waste AD on farm as others are to build them on the edge of urban areas."[210] And as the host of BBDP's initial installations, the cooperative will make the ultimate choice for the location of AD, upgrading, and filling stations – whether they are at the factory in El Alto or closer to the cooperative's cacao producers in the field – and will serve as the basis for the estimation of agricultural and industrial biogas feedstocks in the municipality.

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[204] Apaza, Bernardo; Pacara C., Hoved; Sandoval M., Felipe. Management team – El Ceibo Chocolate Company – La Paz, Bolivia. January 10th, 2015.
[205] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[206] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[207] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[208] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[209] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[210] The Case for Crop Feedstocks in Anaerobic Digestion

The minimum requirements for AD dictate that El Ceibo, let alone the surrounding area, can provide sufficient feedstock for RNG upgrading as "site constraints (access, planning, and adjacent enterprises) together with locally available feedstocks[…] determine what is feasible[.]"[211] There are numerous agricultural and commercial activities (e.g. restaurants) in the department with "considerable potential to make effective use of the by-products from farm based food processing in smaller scale AD plants and it is evident that AD plants can be run effectively on a mix of feedstocks."[212] Lastly, in working the governmental ministries and private sector companies, El Ceibo will not have to provide a workforce for the planning, construction, or maintenance of RNG facilities.

Technologies & Payment

BBDP requests the sum of $5,000,000.00 (USD – €4,454,939,05 as of April 24th, 2016) to construct inexpensive tubular digesters at the El Ceibo factory as they have proven to be effective in capturing biogas from organic waste in variable temperatures at high altitudes utilizing a multitude of feedstocks.[213] RNG upgrading units and electrical generation capacity will be installed as well as an NG filling station for the cooperative's vehicles. The proposal requests these funds from the KfW Bank of Responsibility[214] through renewable energy generation programming[215] as well as R&D grants[216] from Germany Trade and Invest.[217] BBDP requires only a single payment as the proposal is designed to reflect the one-time increase of German GHG emissions due its large-scale development of renewable energy following the closure of its nuclear power facilities – the country aims to generate 60% of its energy through renewable technologies by 2050[218] even though it does not provide any R&D tax incentives.[219]

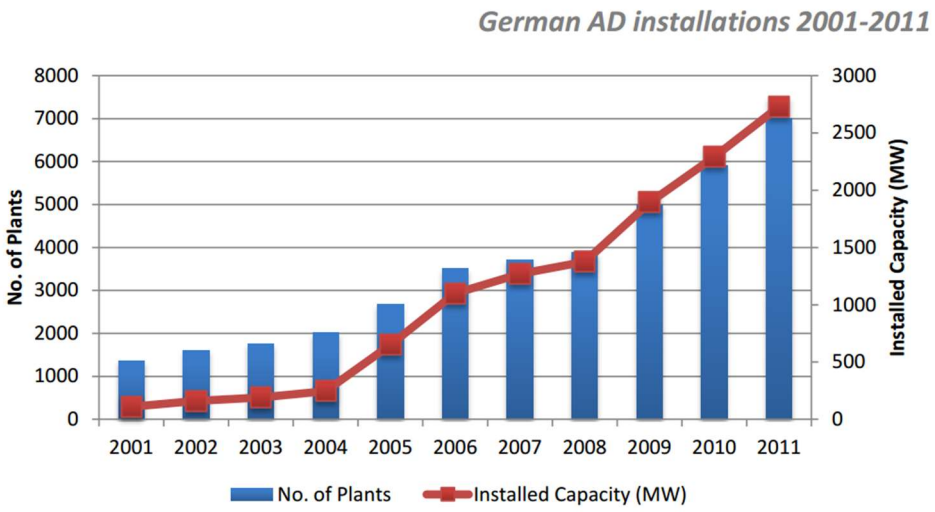
[211] The Case for Crop Feedstocks in Anaerobic Digestion
[212] The Case for Crop Feedstocks in Anaerobic Digestion
[213] Psychrophilic anaerobic digestion of guinea pig manure in low-cost tubular digesters at high altitude
[214] KfW Bank of Responsibility
[215] European renewable energy incentive guide – Germany
[216] R&D Incentives – Germany's High-Tech Strategy
[217] Germany Trade and Invest
[218] Taxes and incentives for renewable energy
[219] Taxation Papers – A Study on R&D Tax Incentives – Final Report

German companies will be contracted to install:

- High-load Fermentation and Tubular AD –
    - Agraferm units can "cope with very high viscosities without having to forgo operational reliability, flexibility and gas yield"[220] and are more easily constructed and operated in areas like El Alto compared to analogues.
- Biogas upgrading facilities –
    - Agraferm Technologies has had experience in upgrading biogas since 2008 and delivers "250 Nm³/h" of RNG from its "AD plant [in] Ketzin, DE."[221]
- NG filling station(s) –
    - "E.ON Gas Mobil – currently operates approximately 100 natural gas filling stations, making the company the largest natural gas filling station operator in Germany."[222]
- CHP generator(s) –
    - Siemens offers NG CHP generators from "4MW to 400MW" for use in variable-scale production activities and baseload power generation.[223]
- NG storage capacity –
    - "E.ON Gas Storage operates the third largest storage reservoir in Germany, Bierwang, which is a former gas deposit located in sandstone strata at a depth of 1,500 metres."[224]

These installations are intended for use by El Ceibo for reducing waste, providing fuel for transportation, onsite power generation, and heat-capture for processing goods. These funds will allow the private sector to operate more efficiently, and upon completion of the initial phase of BBDP, German investments may be recouped through renewable energy supports systems[225] such as the ETS. But more needs to be done by the EU to encourage carbon trading as the market has been lambasted by critics and hovers around the "current lows of €5 (£3.9) a tonne[.]"[226] Through demonstrable success in developing an international climate change abating project, BBDP could provide an important first step for the ETS "needed to push the carbon price up[...] and spur clean investment. For emissions not covered by the carbon market, there will be tussles over how to allocate national responsibility for the 40% goal."[227]

[220] Maximum load fermentation for best gas yields
[221] Gas-to-Grid: Biogas Upgrading Technology
[222] Natural gas as fuel internationally and in Germany
[223] Siemens Gas Turbines – Gas turbines with a capacity from 4 to 400 MW
[224] E.ON Gas Storage operates 15 underground gas storage facilities
[225] Renewable Energy – Support schemes
[226] Germany and Austria call for higher EU 2030 climate ambition
[227] Germany and Austria call for higher EU 2030 climate ambition



[228]

German expertise in biogas development will prove vital to BBDP.

Moreover, the footprint of an RNG utilization facility at sites like the cooperative should be of little concern as the Atlas Disposal/CleanWorld AD in Sacramento, California stores organic waste onsite whilst the digestion of 100 tons/day "can easily be done on one acre"[229] of land. Additionally, the size of biogas capture facilities in urban environments are minimal and are generally attached to existing infrastructure and do not require additional space outside of the upgrading facility. Lastly, RNG flowrates should not be an impediment to the initial success at the El Ceibo factory nor BBDP's regional expansion as they do "not reflect the state of the process unless correlated with the influent amount of organic matter and methane and carbon dioxide percentage. An increase of CO2 with a decrease of CH4 contents are significative of disturbances and can be used as indicator for the beginning of the overload."[230]

BBDP recommends that the remaining funds be used to construct high-load fermentation units for the factory as well as agricultural and commercial production in the surrounding area followed by biogas capture facilities at municipal waste collection and treatment sites in El Alto and La Paz. This portion of the proposal serves as the pilot project for the large-scale, high-altitude AD of organic waste as the process is already generating roughly 95% more electricity than being used for production at the Guabira sugar factory outside of Santa Cruz, [231] but at a much lower altitude.

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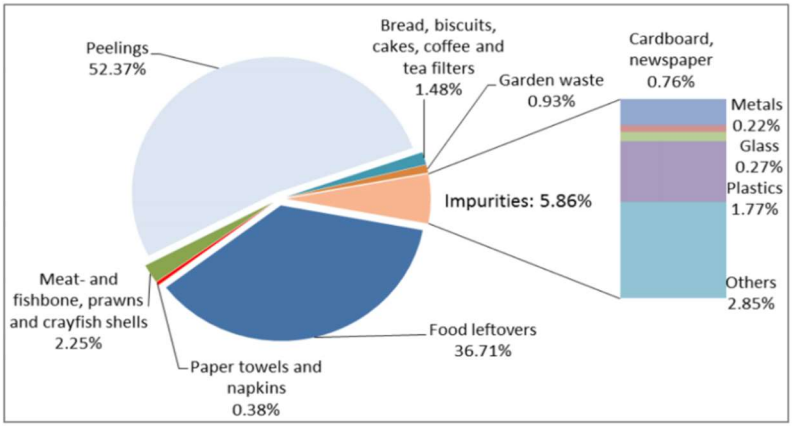
[228] Image – AD Facilities in Germany – "The Case for Crop Feedstocks in Anaerobic Digestion"
[229] Chapman, Katie. CleanWorld – Sacramento, California. 7.23.15
[230] ANAEROBIC DIGESTION – Monitoring and Control
[231] Bolivia's Guabira sugar mill considers new 15MW – report

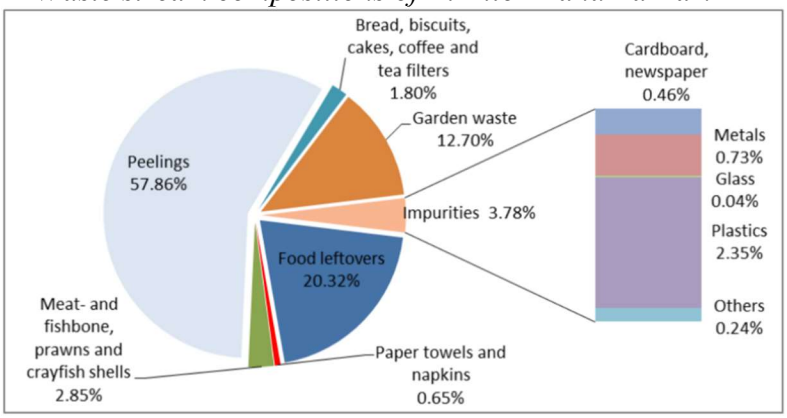
RNG Expansion in Surrounding Areas

The next logical step for BBDP would be the expansion of waste collection at the cooperative's neighbors in El Alto and La Paz, beginning with agricultural producers, markets, and restaurants.[232] From 2005 to 2014, restaurants have seen an 853% growth in sales[233] and concerns regarding storage of waste from these establishments may be alleviated rapidly via anaerobic digestion[234] coupled with biogas capture installations at municipal landfills and wastewater treatment facilities. Unlike in Western nations such as the United States and United Kingdom, organic waste is not necessarily a volume concern, but one of public health as developed nations often see a higher rate of wasted food as compared to the global average of 30-40%,[235] which is still a large amount. A waitress at a local food service establishment has indicated the enterprise would be willing to contribute its waste to BBDP programming should the opportunity present itself in a zero-cost scenario.[236]

[232] Biogas Capture and Utilization: An Effective, Affordable Way to Reduce Greenhouse Gas Emissions and Meet Local Energy Needs
[233] Upwardly mobile
[234] Many years of experience in waste pre-processing and recyling
[235] One third of all food wasted!
[236] Anonymous employee, Layka Restaurant – La Paz, Bolivia. In-person and mediated conversations.



Waste stream compositions of El Alto[237] *and La Paz.* [238]



These collection services can then be expanded even further throughout the two cities to include food and beverage distributers such as the upscale supermarket chain Hipermaxi[239] and Cervecería Boliviana Nacional,[240] producers of the ubiquitous Paceña beer. Throughout Bolivia, "beer consumption increased from 25.8 litres per capita in 2005 to 34.4 in 2013[,]" whilst the American doughnut manufacturer Krispy Kreme "has announced plans to open a dozen stores in Bolivia."[241] The growth of supermarkets in the nation has been astronomical, as well, with a 600% increase in revenue from 2005 to 2014,[242] attributable to the fact that the nation's GDP per capita has ballooned from "$1,200 in 2006 to $3,000 last year" leading to a 50% decrease in the rate of poverty between 2006 and 2013.[243] The aforementioned companies and their competitors

[237] Image – Waste Composition – El Alto, Bolivia – KTH
[238] Image – Waste Composition – La Paz, Bolivia – KTH
[239] Hipermaxi S.A.
[240] Cervecería Boliviana Nacional S.A.
[241] Upwardly mobile
[242] Upwardly mobile
[243] Upwardly mobile

are growing rapidly throughout the nation and generate waste that is a prime feedstock for AD installations[244] such as those recommended BBDP.

> *"About half of [all] waste is organic matter that can be used for biogas generation[…] The topography of La Paz presents a challenge for planning waste management but opportunities exist to improve waste management"*[245]

While this growth is of great benefit to Bolivians, one of the most important aspects of BBDP for German biogas developers will be the data generated by the high altitude anaerobic digestion of organic wastes and is the primary reason for beginning in the cities of El Alto and La Paz. The setting provides numerous challenges, including sourcing the skilled workforce necessary for construction, operation, and maintenance of the installations. The primary obstacle of BBDP's initial deployment will be that of rapidly changing temperatures, extreme weather, and low barometric pressure in a high altitude environment; the results of AD in this location will be of great import for the proposal's technology providers. Fortunately, studies have proven that feedstocks produced in such places like "llama–cow–sheep manure [mixtures were] found to be quite stable with respect to daily biogas production[.]"[246]

The spread of BBDP into the residential communities of El Alto and La Paz may also allow for the construction of distributed energy generation sources,[247] serving as yet another layer of protection against climate change-related calamity. When partnered with local waste producers, the results of successful RNG utilization can then be expanded throughout the nation. The diversification of an installation's feedstocks would also prevent the expansion of what "British land managers have largely avoided" – monoculture production – whilst generating RNG at a more predictable rate "without increasing risk[.]"[248] Sitting high atop the Bolivian Andes, El Alto and the capital of La Paz are two of the nation's largest, most densely populated cities and suffer from worsening pollution problems[249] and economic disadvantages,[250] hampering waste collection, storage, and treatment capabilities.

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[244] Chapman, Katie. CleanWorld – Sacramento, California. 7.23.15
[245] Implementing Waste-to-Biogas in Bolivia – Summary for Policy Makers
[246] The effect of temperature variation on biomethanation at high altitude
[247] The Potential Benefits of Distributed Generation and Rate-Related Issues That May Impede Their Expansion
[248] The Case for Crop Feedstocks in Anaerobic Digestion
[249] Why are my lungs burning (Part 4, La Paz edition)
[250] Poverty Reduction Strategy Paper

"The common practice in La Paz and El Alto today is to capture the landfill gas through passive extraction, and flare the biogas. Thus no energy is being recovered from the process, and valuable resources are being lost."[251]

These symptoms can be alleviated through domestic measures supported by international cooperation such as the remediation of freshwater sources (e.g. Lake Titicaca),[252] "particularly through the increase and protection of riparian vegetation, and restoring river and stream channels to their natural morphologies."[253] The proposal hopes to contribute to this effort by proving non-polluting, organic fertilizers for agricultural production in all regions, thus reducing the risk of organic waste contamination and seepage at landfills and wastewater treatment plants. Lastly, the cost of maintaining RNG installations indefinitely should not worry YPFB analysts as they can be recouped relatively quickly – "Typically, the capital costs of a biogas electricity generating plant are $3,700 to $7,000/kWh" with an initial investment of roughly $400,000 that can be paid back in just under 7 years.[254] Moreover, "[g]overnment financial incentives for producing green energy can reduce the payback period significantly[,]"[255] providing an ideal scenario in which the socialist Bolivian government can act quickly through regulatory bodies to accomplish this goal. Furthermore, the diversification of RNG technologies can keep YPFB's ongoing maintenance costs at a minimum and serve as the basis for national expansion:

Technology	US$/1000 scf biogas†
Pressure swing adsorption	9.21
Chemical absorption	6.32
Water scrubbing	4.74
Membrane separation	4.47
Cryogenic distillation	16.32

† Data for 130 – 161 Nm^3/h product gas output rate [256]

[251] Implementing Waste-to-Biogas in Bolivia – Summary for Policy Makers
[252] Lake Titicaca: Can Small Communities Fight Big Cities that Pollute?
[253] Climate change in mountain regions: a review of possible impacts
[254] Economic Feasibility of Anaerobic Digesters
[255] Anaerobic Digesters
[256] Image – Total Biogas Upgrade Cost in the United States – UC Davis

5. Parties Involved

"The State and any individual or collective person must respect, protect and guarantee the rights of Mother Earth for the well-being of current and future generations."[257]

The various bodies of the governments involved as well as NGO's and German private sector companies will all play different roles, each vital to the success of BBDP. Although the construction of Bolivian biogas installations has been recommended[258] as early as 2010,[259] the propositions are limited in their scope (e.g. relating specifically to MSW in La Paz and El Alto),[260] thereby excluding most commercial and industrial sectors in the nation as well as the majority of the Bolivian population. And while these reports mention that these gases can be upgraded for use in "cooking, transport, heating or electricity,"[261] they do not offer sources of financing for expertise, construction, operation, and maintenance nor do they provide the means for the training of a technically skilled Bolivian workforce. As such, BBDP aims to be a holistic and sustainable model for the "well-to-wheels" development of Bolivian biogas resources.

Bolivia

"With leaner times ahead, socialist Bolivia is wooing business even harder."[262]

President Evo Morales' repeated insistence that international perception of the government's structure does not hold any bearing on his decision-making must be separated from the country's new-found desire for exposure to international capitalist markets.[263] His staunch determination to avoid the "hyperinflation of 1985 when prices rose by 12,000 per cent" is admirable, but comes at a time when global climate change has begun to take its toll on the planet, especially in vulnerable high-altitude environments such as the Andean region home to El Alto and La Paz.[264] Disregarding the systemic origins of climate change,[265] further development

[257] Law of Mother Earth – The Rights of Our Planet – A Vision from Bolivia
[258] Waste-to-Biogas in Bolivia – Promoting Sustainable Development
[259] The Possibilities for Biogas in Bolivia: Symbioses Between Generators of Organic Residue Biogas Producers and Biogas Users
[260] Implementing Waste-to-Biogas in Bolivia – Summary for Policy Makers
[261] Implementing Waste-to-Biogas in Bolivia – Summary for Policy Makers
[262] Mountains to climb
[263] President – or patron
[264] Bolivia – Climate change, poverty and adaptation
[265] Bolivia's Morales blames capitalism for climate change

of the nation is evidently necessary and desired by a majority of Bolivians,[266] but the nation's Law of Mother Earth[267] dictates that environmental concerns must be prioritized over economics.

But if President Morales is to retain his "valuable financial autonomy[,]"[268] he must work to both maximize the nation's NG exports in the currently-depressed commodities marketplace whilst appeasing his electorate via energy rate payment decreases – a path BBDP asserts is viable through the promotion of biogas contributions from its commercial and industrial sectors as well as its citizens. In relying upon the state-owned hydrocarbon producer YPFB, the Bolivian government stands to avoid the price gouging seen prior to the nationalization of the sector. And by developing pipeline injection points[269] throughout the nation for the distribution of RNG through existing infrastructure, YPFB will be better positioned to endure historically low NG prices, especially during times of low production from traditional exploration.

Unlike in Germany, the lack of competition in Bolivia's oil and natural gas sector provides the capability to control prices,[270] allowing the government to provide fiscal stability for YPFB through RNG utilization. However, a "recent drop in oil prices caused Bolivia's energy export revenues to fall by nearly 1% to $6.57 billion in 2014 and is expected to negatively impact the amount of investment in hydrocarbon projects in Bolivia."[271] This point is of particular concern as the nation's public and private sectors currently enjoy heavily subsidized petroleum products (e.g. gasoline) priced well below their market value.[272] And while the nation "meets most of its petroleum product consumption through domestic supply[,]" this is bound to change given the recent spike in per capita GDP and concurrent rise in PPP coupled with the fact that "Bolivia is a net importer of petroleum and other liquids."[273]

The sustainability of these practices will be heavily questioned should the depression in the oil and gas markets continue. Subsequent decreases in YPFB's return on investment may be offset by increased flow of gas throughout the country's pipelines as the cost of transportation in Bolivia accounts "for almost 50 percent of the total final consumer price while transportation

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[266] Power to the people
[267] Law of Mother Earth – The Rights of Our Planet – A Vision from Bolivia
[268] Mountains to climb
[269] Biogas Potential in the United States
[270] Competition in Natural Gas Transportation? Technical and Economic Fundamentals and an Application to Germany
[271] Bolivia – Background – U.S. Energy Information Agency
[272] Power to the people
[273] Bolivia – Background – U.S. Energy Information Agency

costs for oil represent 5 to 10 percent of its final price[.]"[274] Transportation costs represent a major obstacle for the operators of the TransBoliviano Pipeline[275] and, ultimately, YPFB:

> *"Around half of both exports and fiscal revenues depend on hydrocarbons. Prices for Bolivian natural gas exports, almost entirely delivered to Argentina and Brazil, are re-fixed quarterly depending on a basket of fuel prices The strong fall in oil prices will likely push the fiscal balance further into deficit this year."*[276]

BBDP can solidify YPFB's resources and assist in maintaining the relatively low rate of national debt at "31% of GDP as of September 2015"[277] as the company's ""take" from some fields" roughly 82% of the final sale price.[278] Although technically a publicly owned corporation, YPFB manages its own finances, exploration efforts, and is subject to the movements of the international commodities market. The governmental control of the company should not see as a threat to success of the proposal as its size and international relationships provide tremendous revenue. Moreover, BBDP represents a miniscule allocation of the company's resources – "All told, YPFB has a $30bn investment programme for the next 10 years."[279] YPFB's participation in BBDP is vital, however, as "[i]f Bolivia were a private company, it would be in trouble, because it is not growing its reserves portfolio."[280]

The proposal prefers the limitation of bureaus, corporations, and ministries in both nations as communication between all parties involved must be rapid and decisive. Due to the recent accusations of abuse of power involving the misappropriation of state funds,[281] the oversight of BBDP will be a less arduous task when given a more focused level of oversight. Moreover, "the Vice-Ministry of Electricity and Alternative Energy has only 3 people" employed by the bureau and, like many other bodies, "frequent leadership turnover" brings about "drastic change, especially at smaller agencies."[282]

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[274] Analysis of the Hydrocarbon Sector in Bolivia
[275] Gas – TransBoliviano Natural Gas Pipeline
[276] Bolivia – Frontier country report
[277] Bolivia – Frontier country report
[278] Power to the people
[279] Power to the people
[280] Power to the people
[281] Escobar, Gabriel – DCM; Ballesteros Ferrel, Mauricio – Environment, Science, Technology and Health Specialist; del Carmen Palma, Olga – Information Specialist. U.S. Embassy, La Paz, Bolivia. 2.29.16
[282] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16

Public Sector

BBDP seeks to streamline the process of governmental approval by limiting involvement of unnecessary ministries as the more institutions that involved, "the more difficult the ride."[283] "There are some problems with corruption and transparency"[284] in various regions of the country, as well, but the organizations involved are necessary as Bolivian development is "almost always done through a government agency or government-owned company"[285] –a practice lamented by Escobar.[286] Furthermore, energy is "such a large issue that you must always deal with the national government."[287] Doing so ensures operations will run smoother whilst communications between planning organizations and observers will be less convoluted.

Primary

- Ministry of Foreign Affairs[288]
    - Serves as the initial point of contact for the Bolivian and German governments to coordinate logistics for planning and shipping in order to provide a more seamless transition to construction of BBDP via the Ministry of Hydrocarbons and Energy.
- Ministry of Hydrocarbons and Energy[289]
    - Facilitates cooperation between the GIZ, private sector companies, and YPFB.
    - Dictates the requirements for electrical grid interconnection.
    - Sets the pricing structure for NG filling stations and electricity rates.
    - Delineates areas of greatest need for RNG access and eventual pipeline injection.
    - Assists in the development of BATTS curricula.

Secondary

- Ministry of Public Works, Services, and Housing[290]
    - Promotes the contribution to RNG utilization by residential communities as well as agricultural and commercial operations in both rural and urban areas.
    - Point of contact for consumer feedback regarding RNG-related costs.
    - Assisted by the Ministry of Productive Development and Plural Economy[291] for the incorporation of underserved communities throughout Bolivia.

Private Sector

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[283] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[284] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[285] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[286] Escobar – Page 38
[287] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[288] Ministry of Foreign Affairs
[289] Ministry of Hydrocarbons and Energy
[290] Ministry of Public Works, Services, and Housing
[291] Ministry of Productive Development and Plural Economy

- El Ceibo Chocolate Company
  - See: Case Study
- YPFB[292]
  - Owns, operates, and maintains RNG facilities outside of El Ceibo.
  - Dictates the size and technology requirements for municipal landfill and wastewater treatment biogas capture locations.
  - Reports RNG data to the Ministry of Hydrocarbons and Energy.
  - Controls pipeline injection points and flowrates.
  - Provides CSR funds for the creation of BATTS.
  - Assists in the development of BATTS curricula and RNG job-placement programs through CSR.

Germany

Germany's role in BBDP will range from funding and planning through various governmental ministries coupled with the initial deployment of human capital and technologies of the private sector. The nation has been a global leader in the capture of and upgrading of waste gasses for usage in combustion engines as well as for electricity generation – there were 23 such German facilities in operation as early as 2006.[293] The country has also assisted the Bolivian government in developing a more sustainable sanitation model for the nation.[294] Additionally, the promotion of international collaboration[295] on renewable energy and GHG emissions reductions strategies has been codified by the European Union.[296]

Observers have noted that "Germany needs to speed up the pace of reducing its GHG emissions if it wants to meet its 2020 goals" but add that the "persistently high price of NG in Europe"[297] has made that process difficult. Exacerbating this situation is the fact that Germany "was forced to back down from a proposal to impose fees on the oldest, and dirtiest, power plants, to encourage their phase-out[,]" resulting in increased fossil fuel burning with renewables accounting for only 26% of Germany's "gross electricity production last year[.]" [298] Thankfully, the municipalities of El Alto and La Paz, Bolivia are poised to assist in reversing these trends:

> *"The international community can be called to help the municipal government put in place incentives for improved solid waste management, and design integrated schemes for biogas production and utilization, as well as overcome the key barriers to technology transfer and*

[292] Yacimientos Petrolíferos Fiscales Bolivianos
[293] Status of Biogas Upgrading in Germany
[294] German Development Cooperation in the Sanitation Sector
[295] European Commission – International Cooperation and Development
[296] Renewable energy directive
[297] Nuclear Plant Closing Reflects Overhaul of Germany Energy Production
[298] Nuclear Plant Closing Reflects Overhaul of Germany Energy Production

deployment. The climate mitigation gains are likely to be significant, thus bringing also global benefits from the effort."[299]

Public Sector

The German government's finances are "more than adequate"[300] for investments of BBDP's size while the Bolivian "economic situation has improved significantly in the last few years. There is stable economic growth."[301] Moreover, the relationship shared by the Bolivian and German people is deep and manifold as Germans account for 3% of Bolivia's population.[302] At roughly 375,000, Germans are the country's largest expat group and their native tongue is one of the most-used languages in Bolivia.[303] Their respective governments share strong bonds politically, economically, and culturally as well; Germany's Federal Foreign Office maintains two missions in Bolivia.[304] The German government has previously "committed total funding of 45.2 million euros for development cooperation[.]"[305]

Primary

- GIZ[306] – The ministry operates through two distinct and independent bodies:[307]
    - GIZ Technical Agency[308] – Located in the German Embassy in La Paz,[309] the agency does not work with public money, "only technical advisement."[310] Of the roughly 200 employees, "about 10 are German"[311] thereby making the incorporation of indigenous Bolivians in the fields related to BBDP possible. The Technical Agency has seen an increase in participation recently as the Bolivian economy has "boomed in the last ten years."[312]
    - The GIZ' Technical Agency's main objectives are:
        a. Promoting decentralized, "good" governance
        b. Promoting access to clean water and sanitation services

[299] Implementing Waste-to-Biogas in Bolivia – Summary for Policy Makers
[300] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[301] Bolivia – Situation and Cooperation
[302] Bolivia – Chronology
[303] Ethnic Germans in Bolivia
[304] Bolivia – German missions
[305] Bolivia – Situation and Cooperation
[306] German Society for International Cooperation
[307] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[308] Products and expertise
[309] German Development Cooperation
[310] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[311] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[312] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16

c. Promoting rural development[313]

The agency is also committed to elevating environmental protection and "renewable energy to a higher level as a fourth priority or objective."[314] BBDP aims to incorporate RNG in accomplishing that goal.

i. Provides the technical assistance to the Ministry of Hydrocarbons and Energy, YPFB, and German private sector companies.
ii. Facilitates the importation of technical experts from Germany.
iii. Assists in the development of BATTS curricula and RNG job-placement programs.

- KfW Bank of Responsibility – Operated by the GIZ in Frankfurt, Germany. "Germany's federal government-owned development bank, and the German state development banks have a wide range of programs available for [renewable energy]. The advantage of these programs is that they are open to all types of technology and generally cover higher R&D costs."[315]
  i. Consults with the GIZ Technical Agency as the primary source of funding to BBDP and receives proposals from private sector companies through petitions to the German Ministry of Economic Affairs and Energy[316] as the bank's lending practices are "rather strict."[317]
  ii. Manages the recovery of BBDP investments through ETS filings with additional support from the German Ministry of Economic Affairs and Energy as well as the German Ministry for the Environment, Nature Conservation, and Nuclear Safety.[318]

Secondary

- German-Bolivian Chamber of Commerce and Industry
  - Consultant to the Ministry of Hydrocarbons and Energy for community outreach and management of RNG expansion in El Alto and La Paz.
- Germany Trade and Invest
  - Consultant for marketing and technologies "that are primarily targeted at" SMEs – "The "Central Innovation Program for SMEs" (ZIM) is the best known of these programs; its aim is to promote innovation and competitiveness at SMEs."[319]

Private sector

The pricing for RNG technologies varies upon manufacturer, model, and size requirements but can accommodate the needs of small-scale organic waste producers as well as large agricultural activities such as cattle ranching and coca production. However, for the initial

[313] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[314] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[315] R&D Incentives – Germany's High-Tech Strategy
[316] Ministry of Economic Affairs and Energy
[317] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[318] Ministry for the Environment, Nature Conservation, and Nuclear Safety
[319] R&D Incentives – Germany's High-Tech Strategy

installations proposed by BBDP at El Ceibo, low-cost tubular digesters have "no significant differences between[…] models."[320] Biogas capturing facilities often over-produce RNG as the volume of feedstock can be unpredictable.[321] As such it will be necessary to construct NG storage and/or pipeline injection capacity at BBDP sties. Injection points can be installed at- or near-cost, running as low as $300,000[322] given favorable Bolivian regulations. The various companies will operate these facilities include:

- Agraferm Technologies[323] (Primary)
  - See: Case Study
- GASCADE Gastransport[324] (Primary)
  - As world leader in the pipeline injection of RNG[325] and proponent of prioritizing environmental regulations throughout the NG distribution process, provides pipeline injection technologies for BBDP installations.
- Gasunie Deutschland[326] (Secondary)
  - Specializes in pipeline injection repair – the size and topography of Bolivia may create periods where the necessity of a skilled workforce is greater than that deployable by GASCADE prior to BATTS' implementation.
  - Provides alternative pipeline injection technologies for BBDP installations.
  - Assists in the development of BATTS curricula.
- E.On[327] (Primary)
  - See: Case Study
  - Assists in the development of BATTS curricula.
- HZI BioMethan[328] (Secondary)
  - Provides alternative AD technologies for BBDP installations.
  - Assists in the development of BATTS curricula.
- Schwarting Biosystem GmbH[329] (Secondary)
  - Provides alternative AD technologies for BBDP installations.
  - Assists in the development of BATTS curricula.
- Siemens[330] (Primary)
  - See: Case Study
  - Assists in the development of BATTS curricula and RNG job-placement programs through CSR.[331]

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[320] Psychrophilic anaerobic digestion of guinea pig manure in low-cost tubular digesters at high altitude
[321] Renewable Natural Gas – Clean Green Energy
[322] DRAFT Comparative Assessment of Technology Options for Biogas Clean-Up
[323] Your partner for economical AD plants
[324] GASCADE Gastransport
[325] Feed-In of Biogas
[326] Gasunie Deutschland
[327] Natural gas mobility – Fuelled for the future
[328] HZI BioMethan
[329] Schwarting Biosystem GmbH
[330] Siemens
[331] Sustainability – Siemens

- TUBA Turbine[332] (Secondary)
    - Provides alternative CHP technologies for BBDP installations.
    - Assists in the development of BATTS curricula.

International Organizations, NGO's, & Think Tanks

- European Union
    - Provides the mechanism for Germany to recoup public investments via the ETS in order for the nation to meet its EU climate goals.[333] The EU also has a relationship with Bolivia by promoting food security in the nation – "Since 1997[…] the EU has contributed with €124 million to strengthen Bolivia's capabilities in this field."[334]
- DOEN Foundation,[335] Friedrich Ebert Foundation,[336] & Konrad Adenauer Foundation[337]
    - These organizations, along with Siemens and YPFB CSR funds, provide continuing funding for BATTS. The DOEN Foundation, alone, funds "both large and small initiatives such as a project, a programme or" institutions via "subsidies, participations, loans and guarantees" with of over €22 million.[338]
- The Ecologic Institute[339]
    - Provides legislative consultation to both governments to overcome the challenges posed by a transition from fossil fuels to renewable energy generation technologies in addition to properly prioritizing and codifying environmental and ecological policies as compared with the needs of regional development.[340]
    - Provides technical consultation for environmental concerns regarding the ecological degradation caused by biogas soil and water contamination in partnership with the Bolivian Sustainable Development Hub.[341]
- GAES[342]
    - Although publicly funded, the organization is a private institution that will facilitate the creation of a venue and curricula for BATTS programming such as the study of BBDP's economic performance, environmental impact, and the reshaping sustainable development in the nation, moving forward.
    - Assists in the procurement of accreditation and faculty members.
- The Heinrich Böll Foundation[343]
    - Advises German governmental ministries in authoring appeals for BBDP's general approval from the Bundestag[344] as well as the KfW Bank of Responsibility for the specific allocation of BBDP's development funds.

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[332] TUBA Turbine
[333] Graf, Andreas. Researcher, Ecologic Institute – Berlin, Germany. 3.23.16
[334] Plurinational State of Bolivia
[335] DOEN Foundation
[336] Friedrich Ebert Foundation
[337] Konrad Adenauer Foundation
[338] DOEN Foundation
[339] Ecologic Institute: Science and Policy for a Sustainable World
[340] Graf, Andreas. Researcher, Ecologic Institute – Berlin, Germany. 3.23.16
[341] Bolivian Sustainable Development Hub
[342] German Academic Exchange Service
[343] Heinrich Böll Foundation
[344] The Parliament of the Federal Republic of Germany

- Promotes BBDP to the German government and its citizenry.
- Assists in the development of BATTS curricula.

Notable Omissions

- United Nations[345]
  - The UN will not be involved in BBDP as its bureaucratic structure would only serve to hinder the proposal's development as it will only add unnecessary levels of bureaucracy and complexity. Moreover, it's relationship with the nation is somewhat precarious and stands little chance of winning favor with President Morales – a former cocalero – given the organizations targeting of coca producers in Bolivia during its fight against the drug trade at an international level.[346]
- World Bank[347]
  - Although the institution has maintained a large presence in Bolivia for many years – development projects began prior to 1964 as the institution "supported the reforms through a rural development programme (Accion Andina)"[348] – its history with the nation has been debated by observers,[349] with many arguing that the effects of its development efforts in the nation have led to negative consequences.[350] Moreover, the organization has "a lot of institutional turnover,"[351] preventing a strong commitment to BBDP's holistic structure and long-term environmental remediation efforts. While individuals within the organization may be of great service to BBDP (e.g. environmental consultation), it has not been included as a participant in the proposal.

[345] United Nations Development Programme (UNDP) – Bolivia
[346] As UN Orders Expanded Global Drug War, Critics Fight Back
[347] World Bank – Bolivia
[348] Antsee, Margaret. Op-ed column.
[349] Foreclosing the Future: The World Bank and the Politics of Environmental Destruction
[350] World Bank wants water privatized, despite risks
[351] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16

6. National Expansion of BBDP

Unlocking the Full Potential of Biogas Resources in Bolivia

"In addition to the priorities set out for long-term activities, Germany is currently involved in renewable energies and in the management of nature reserves."[352]

The spread of RNG utilization throughout various sectors in the nation represents the holistic model of BBDP that aims to provide equitable access to the fuel for all citizens, in one form or another. The pilot at El Ceibo leaves open the door for RNG elaboration across all regions and sectors of Bolivia and provides areas of future academic and technical research. The extension of BBDP's RNG network could also foster additional cooperation between the nations involved for academic, financial, and technological knowledge-sharing. Germany's Institute for Advanced Sustainability Studies[353] could provide vital analyses of the nation's burgeoning renewable energy sector whilst the Institute for Transport Research[354] could assist in the development of a network of charging stations for the nation's ambitious EV plans.

Agriculture

"A study[…] concluded there are almost 2m hectares of good agricultural land in Santa Cruz that lies uncultivated, representing an extra $3.8bn in revenues in addition to the $2.2bn that the province's agricultural sector currently generates."[355]

The agricultural sector of Bolivia stands to benefit the most from BBDP, initially, and for a variety of reasons. Although oil and NG exploration represents the vast majority of national exports, totaling 54% of revenue in 2014,[356] food production[357] and cattle herding[358] account for 13.32% of GDP in 2013, trending similarly to that of similar commodity prices.[359] The sector is poised to provide a tremendous feedstock for BBDP facilities and contribute to ecological conservation and remediation in a similar manner to El Ceibo by eliminating chemical fertilizers through the utilization of AD byproducts. Byproducts from crops like coca, quinoa, and soya will be popular RNG raw materials, but other ranching activities may provide even better feedstocks

[352] Bolivia – Situation and Cooperation
[353] Institute for Advanced Sustainability Studies
[354] Institute for Transport Research
[355] Betting the farm
[356] Bolivia – Background – Marcon International
[357] Feasibility Study of Anaerobic Digestion of Food Waste in St. Bernard, Louisiana
[358] An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities
[359] Agriculture – value added (% of GDP) in Bolivia

than previously speculated as "[l]lama manure appears to be the best raw material from the Altiplano[.]"[360]

From alpacas and guinea pigs[361] in the Andean region to cattle and pork in the East,[362] various types of animal manure are high-quality feedstocks.[363] The payment for this portion of BBDP's enlargement may come from any combination of the profits from BBDP programs to loans from the Andean Development Bank[364] to subsidies from Bolivian government, itself. Agricultural production for food such as quinoa has boomed I recent years and soya, alone, represents nearly 1/3 of the nation's foreign exchange, a massive boon for BBDP's expansion when considering that "the government is aiming to invest more than $5bn in agriculture, and about $2.5bn will be spent on building agro-industrial complexes[,]" the majority of which will be aimed at "small producers in the western highlands and non-traditional exports[.]"[365]

These figures are of great import as BBDP's operational costs pale in comparison to proposed Bolivian agri-investments, positively affecting the sector's capacity to contribute to both GDP growth and reducing GHG emissions. The identification of areas ripest for expansion is to be assisted by the Bolivian Ministry of Rural Development and Land.[366] And unlike Escobar's citation of Robert McNamara's belief that there were certain farms that were too small to be considered for rural development programming,[367] BBDP can accept waste at centralized locations from farms of all sizes producing a bevy of feedstocks:

What can I grow? Feedstock	Biogas Yield m3/tonne
Grass silage	160-200
Maize silage	170-220
Triticale	160-200
Ryegrass	160-200
Sugar beet	170-180
Fodder beet	170-180

[368]

[360] Anaerobic Digestion of Solid Residues on the Bolivian Altiplano
[361] Psychrophilic anaerobic digestion of guinea pig manure in low-cost tubular digesters at high altitude
[362] Betting the farm
[363] Cow Power Fun Facts
[364] Development Bank of Latin America
[365] Betting the farm
[366] Ministry of Rural Development and Land
[367] Escobar – Page 160
[368] Image – Biogas Yields – The Case for Crop Feedstocks in Anaerobic Digestion

Pipeline Injection – Commercial, Industrial, & Residential Uses

The industrial applications for BBDP are congruous with those of any other industrialized nation as the modern Bolivian production sector is relatively diversified, especially when taking into account the nation's historic struggles to develop and grow its economy.[369] BBDP recommends expansion beyond fuel production for industrial and residential (i.e. district) heating via CHP as Iceland's ICEIDA has proven that it is possible to fund renewable energy projects in developing nations as expansion into sectors beyond power provision is well documented, such as through the "[u]se of geothermal resources for drying of agricultural commodities in East Africa."[370] This will help reduce costs and GHG emissions whilst increasing productivity by reducing fuel consumption.[371]

Much like home energy audits reveal waste in oft-used or overlooked areas (e.g. single-paned windows and roof color),[372] BBDP could be further expanded into the homes of Bolivians in several ways. As waste producers, residents could contribute to local AD facilities, providing fuel and/or natural fertilizers for their community. As a consumer, residents of cities such as El Alto and La Paz would be able to heat their homes with gas generated at nearby landfills or wastewater treatment plants. Moreover, biogas refiners produce a tremendous amount of heat that can generate steam, which could then be transported alongside NG pipelines to prevent extreme cold from damaging existing infrastructure, as even developed nations like Germany have a difficult time selling waste heat to customers – as of 2006, < 30% of producers sold surplus heat on the market.[373]

[369] Power to the people
[370] The Geothermal Exploration Project
[371] Energy 101: Energy Efficient Commercial Buildings
[372] Energy 101: Daylighting
[373] Status of Biogas Upgrading in Germany

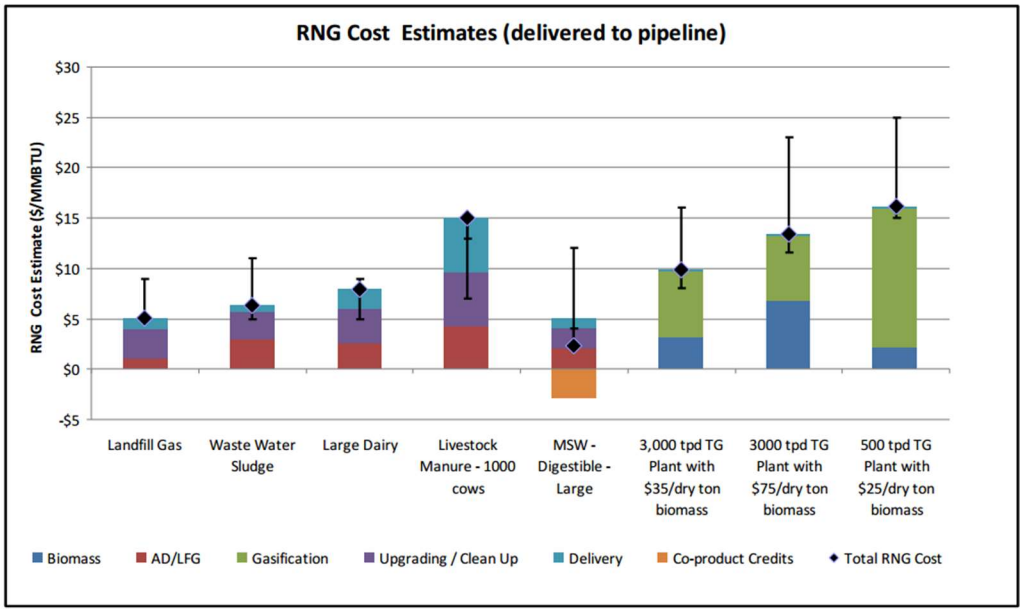
374

Existing Bolivian NG pipeline infrastructure.

However, the primary concern of BBDP is to promote the injection of RNG into Bolivian pipelines. The majority of injection costs in the United States are inflated due to the regulations and taxes of individual states[375] (other states often rely on those decided upon in the state of California)[376] as well as the interconnection fees demanded by utility providers. These costs can be avoided in Bolivia as the national government controls the methods of NG delivery, requiring an investment of only "$200 – $300/ft. for pipeline extension" from upgrading facilities to major pipelines[377] in the surrounding area. These low costs will allow for the rapid expansion of BBDP throughout all NG-consuming sectors in the nation.

[374] Image – Bolivian Natural Gas Pipelines – YPFB
[375] Biogas in the United States – An Assessment of Market Potential in a Carbon-Constrained Future
[376] Recommendations to the California Public Utilities Commission Regarding Health Protective Standards for the Injection of Biomethane into the Common Carrier Pipeline
[377] DRAFT Comparative Assessment of Technology Options for Biogas Clean-Up

Figure II **RNG Cost Estimates by Feedstock (Delivered to the Pipeline)**[26]



[378]

Education & Indigenous Incorporation – BATTS

Although Escobar's prescriptions for the rolling-back of development often begin with the lambasting of educational exchanges, the relationship between Bolivia and Germany has generated a quality program in the nation through the GAES. Through the creation of BATTS, the organization will be able to offer education and training to Bolivians under the guidance of skilled technicians for the long-term operation and maintenance of BBDP's RNG installations. These workers can be a part of realizing the nation's goal of increasing the "electric energy supply to around 4,800MW from the 1,600MW"[379] it currently produces in a clean and sustainable manner. This could lead to a new "green" Bolivian energy market, akin to what has been proven[380] and diversified[381] in numerous developed countries.

And if traditional indigenous resistance is to be the "symbol" or "meaning" of a development discourse,[382] BBDP can serve as a symbol of the Bolivian fight against climate change and traditional international development. Once again, the Law of Mother Earth provides guidance in the incorporation of indigenous peoples into the process. Because "the remaking of

[378] Image – RNG Pipeline Costs – NPC
[379] Power to the people.
[380] Think Green Jobs Can't Grow? 6.5 Million Workers Think You're Wrong.
[381] The Project: Manzana Wind Power Project Creates Renewable Energy and Local Jobs
[382] Escobar – Page 167

development"[383] must prioritize culture and identity, the proposal will proceed with projects that incorporate both and present a minimal incursion into these areas. BBDP promotes a symbiotic learning environment through BATTS by providing "healthier regimes of accumulation and development" and "conditions that are more conducive to local and regional experiments[.]"[384]

El Ceibo provides a model institution for beginning such a task as the company "is an amalgamation of Aymara and Quechua and other groups."[385] Moreover, Andeans are key drivers of development and "try to incorporate the indigenous groups of the lowlands, as well."[386] These groups have resisted the increase in yields that come with GMOs in the name of protecting the environment while key Andean organizational concepts – "assemblies, rotations, leadership" – led to the incorporation of "indigenous peoples as opposed to excluding them."[387] BATTS will target the training of indigenous workers for skilled positions at RNG facilities throughout the nation in cities such as El Alto which "is arguably Latin America's largest indigenous city" and serves as "the modern centre of the Aymara, who number some 16m[.]"[388]

Electrical Generation & Interconnection

"For those who have access to electricity, natural gas-fired plants and hydropower are the dominant sources of Bolivia's electricity supply."[389]

While BBDP's initial deployment would reduce costs at El Ceibo, it can be used to expand underdeveloped electrical infrastructure in Bolivia and aid in maximizing profits from the exportation of renewable electricity – "Bolivia plans to invest almost $6.9bn in generation, noting that exporting electricity to Brazil and Argentina would be more profitable than exporting unprocessed commodities."[390] These are righteous ambitions, but without a plan for the sustainable development of additional generation capacity the nation will see its GHG emissions skyrocket disproportionately to domestic consumption. CHP units provide optimal efficiency for RNG power generation,[391] aiding in reducing urban pollution in the process. To achieve these

[383] Escobar – Page 98
[384] Escobar – Page 100
[385] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[386] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[387] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[388] Survival instincts
[389] Bolivia – Background – U.S. Energy Information Agency
[390] Power to the people
[391] The optimal heat recovery concept for biogas plants

goals, it will be essential to promote the interconnection of renewable generation capacity with existing electrical infrastructure.

This is of great concern for rural and migratory members of Bolivian society as urban inhabitants represent the vast majority of the population with access to power – "more than 99% of city dwellers have access to electricity, compared to 66% of those living in rural areas."[392] Unfortunately, while "independent and small-scale generation is no problem" in Bolivia, interconnecting with existing infrastructure poses "major challenges" due to pushback from traditional (i.e. fossil fuel-based) energy providers.[393] The interconnection of RNG power generation units could help to expand existing electrical infrastructure to provide more reliable and equitable access to the utility in rural areas, instilling further confidence in the national government's ability to provide for its citizenry.

[394]

Bolivians wishing to share clean energy resources already have an excellent example to follow of a microgrid working in a rapidly changing climate similar to that of the Andean region.[395] These installations may also help with public health concerns in cities such as Santa Cruz where the population has swelled to roughly 2 million, making it the nation's largest and

[392] Bolivia – Background – U.S. Energy Information Agency
[393] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[394] Image – Bolivian Electrical Infrastructure
[395] Richard Branson and NRG test clean microgrid on private island

"one of the fastest-growing cities in the world."[396] Much like BBDP's initial expansion beyond El Ceibo's walls in El Alto, the proliferation of RNG utilization facilities can spread to other urban areas such as Cochabamba[397] and Sucre[398] which can just as easily incorporate community-organized, scalable[399] waste disposal programs in partnership with businesses, farmers, restaurants, and more for AD.

Salar de Uyuni & Tourism

"We want, in a few years, to be able to drive a Bolivian electric car."[400] [Castro, Marcelo]

BBDP recognizes that the exploitation of natural resources in the Salar de Uyuni is a foregone conclusion – roughly 50% of the worlds known lithium reserves[401] sit in the flat's "10bn tonnes of salt"[402] – and represents a major part of Bolivia's plans for developing value added products, such as entering the EV market. But the protection of the surrounding ecosystem must be prioritized above all else as "the largest salt flats in the world" serve as a major tourist attraction – "in 2014, 50,000 arrived from Asia alone, up from 1,000 in 2011."[403] And while its development is inevitable when given the current economic and political climates,[404] it can also be a model for sustainable development through the promotion of renewable and distributed energy resources. And as "the government is determined to push Bolivia up from its ranking of 100 out of 141 on the 2015 World Economic Forum's Travel and Tourism Competitiveness Index[,]"[405] it has the opportunity to promote ecotourism through "glamping – luxury camping[.]"[406]

The Bolivian government hopes to attract some *"7.1m visitors a year by 2020, up from 3.1m in 2014. It intends to invest $400m to help it achieve that, and is seeking a further $400m from private-sector investors."*[407]

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[396] Betting the farm
[397] Biogas Technology in Bolivia (Region Cochabamba)
[398] Bolivian-German Cultural Institute of Sucre
[399] Anaerobic Digestion from the Laboratory to the Field: An Experimental Study into the Scalability of Anaerobic Digestion
[400] Extra charge – Salt flat stores battery power
[401] The battle for the Salar de Uyuni
[402] Extra charge – Salt flat stores battery power
[403] Premium potential
[404] The battle for the Salar de Uyuni
[405] Premium potential
[406] Premium potential
[407] Premium potential

As the tourism sector is a major contributor to waste, this could be seen as a boon for BBDP programs as "Marriott and Starwood of the US and Accor of Franc are among the international groups that are building premium hotels in the country."[408] The challenges posed by RNG utilization in the high altitude environment (the Salar sits at 11,000ft. above sea level) will have been overcome by this time, allowing for BBDP's expansion into the region. Further strengthening the bonds between Bolivia and its international trade partners is the fact that the lithium initially produced from the Salar will most likely head to production facilities outside of the nation – to factories in China for mobile phones, to Tesla's Nevada Gigafactory for its Powerwall[409] and fleet of vehicles, and to German car manufactures such as BMW which plans to go fully electric within the next 10 years.[410] But time is of the essence as Comibol has already funded a $19m pilot plant currently "producing potassium chloride and lithium carbonate[.]"[411]

"Comibol says it intends to pour $790m into" developing lithium reserves throughout the nation in the hopes of exporting some *"168,000 and 10,000 metric tons annually, between 2021 and 2025 respectively."*[412]

Transportation

The impact on global climate change from the transportation sector is undeniably large,[413] however, Bolivia has the capacity to rapidly reduce its sectoral contributions in a short amount of time.[414] Outside of supplying lithium for EVs, BBBP's spread to the transport sector will rely on the expanded promotion of NG vehicles by the national government. The recently-introduced fleet of 200 NG-powered buses in Santa Cruz[415] has proven so successful that the nation is already planning to convert and additional 100 diesel-powered units to CNG.[416] These vehicles serve as a prime example of the climate change-abating potential of RNG through BBDP's holistic approach as the NG-powered buses and cars already on the road can run off of the fuel sans modification, thereby reducing their energy impact even further.[417]

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[408] Premium potential
[409] Powerwall – Tesla Home Battery
[410] BMW Going All-Electric
[411] Extra charge – Salt flat stores battery power
[412] Extra charge – Salt flat stores battery power
[413] Transportation's Role in Climate Change – Transportation and Greenhouse Gas Emissions
[414] Biogas upgrading and use as transport fuel
[415] Bolivian Government Supplies 200 CNG Engines for Santa Cruz Buses
[416] Bolivia Begins New Diesel to CNG Transit Bus Conversion Project
[417] Renewable Natural Gas (RNG) – A Clean, Secure, Commercially Viable Replacement for Diesel Fuel Today

Additionally, the blending of biofuels like RNG with traditional NG may be incentivized by the government in order to promote the fuel's utilization much like in the United States' via the RFS[418] and RIN[419] systems. These cleaner-burning gases could then be utilized to generate non-traditional synthetic fuels for airline transportation[420] at a reduced cost.[421] This could help to achieve GHG emissions reductions goals as Bolivia has seen a 144% increase in flight sales from 2005 to 2014.[422] And should the manufacturing of vehicle conversion kits stagger and/or the demand for NG vehicles expand to a point wherein diesel-to-CNG modifications overstress the market's capacity to provide necessary parts, other technologies can act as a stopgap whilst achieving similar reductions in GHG emissions – diesel engines both small and large can be converted to run off of waste fats, going by the "grease guzzler"[423] moniker.

"A leading Middle Eastern airline has expressed interest in investing"[424] funds to turn Santa Cruz's Viru Viru Airport into a regional hub for South American air travel.

Lastly, RNG-powered buses could become the model for sustainable mass transportation[425] in the region as nations like Colombia and Ecuador have successfully rolled out bus rapid transit systems in recent years.[426] These conversions will reduce pollution as the battery-hybridization of diesel engines, oft-used in Bolivia, is not technically possible.[427]Additionally, the necessity for used vehicles and recycled parts in Bolivia is great, especially in rapidly growing urban areas such as Santa Cruz. However, these vehicles – always imported – often run without exhaust filtration systems, disproportionately contributing to the country's GHG emissions.[428] Therefore, it is necessary to introduce preexisting pollution-reducing technologies such as air filters, catalytic converts, exhaust controls, and more into the Bolivian transport marketplace.

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[418] Renewable Fuels: Regulations & Standards
[419] RFS Voluntary Quality Assurance Plans
[420] REACT4C – Reducing Emissions from Aviation by Changing Trajectories for the Benefit of Climate
[421] Economic incentives to mitigate greenhouse gas emissions from air transport in Europe
[422] Upward mobility
[423] Grease Guzzlers
[424] Premium potential
[425] Biogas Upgrading to Vehicle Fuel Standards and Grid Injection
[426] Case Study: Colombia's Bus Rapid Transit (BRT) Development And Expansion
[427] Why are there no diesel hybrid cars?
[428] Status of Fuel Quality and Vehicle Emissions Standards: Latin America and the Caribbean

The German Scrappage Scheme and similar programs around the world created a large stockpile of such equipment in the form of viable, non-working vehicles when these governments sought to "replace older cars with new and more ecological cars."[429] The sights of the nation's transportation planning should focus on the sustainability of current systems and vehicles as there are numerous obstacles to even a partial EV rollout,[430] should the nation accomplish its lithium development goals. Failure to properly maintain its current transport fleet could result in the loss of economic progress and productivity.

"Worldwide there are over 11 million NGVs on the road – and the trend is rising. Every year over 1 million new NGVs are registered worldwide. In Europe alone, more than 1 million NGVs are in service. Outside Europe, most NGVs are to be found in Argentina, Brazil, India, China and the USA and they are now conquering the global market."[431]

7. Conclusions & Recommendations

"The investment drive is likely to be a hard slog."[432]

The culmination of BBDP's full expansion throughout Bolivia could result in the pipeline transportation of RNG to neighboring nations, possibly helping to repair its relationship with Chile.[433] The ecological ramifications of RNG utilization should be of little concern as BBDP prioritizes the consistent monitoring of biogas installations using the best possible practices developed by German corporations. A renewed focus on environmental protection would aid President Morales' ambitions to expand the nation's hydrocarbons sector, and he must do so without "dismissing criticism" from environmental activists; this includes dissuading Vice President [Álvaro García] Linera from painting his opposition as "green Trotskyites[.]"[434]

While the development of Bolivia's biogas resources will not take place immediately, nor will it be a panacea for the economy's much needed diversification beyond oil and gas, it will serve several major interests concurrently. Primarily, it will secure YPFB's NG revenue whilst reducing national GHG emissions in providing a model for cooperation between international public and private sectors, a necessary promotion due to Bolivia's ranking as "157th out of 189

[429] Pull-Forward Effect in the German Car Scrappage Scheme: A Time Series Approach
[430] Goletz, Mirko. Research Associate, Institute of Transport Research – Berlin, Germany. In-person and mediated conversations.
[431] Natural gas mobility – Fuelled for the future
[432] Mountains to climb
[433] Mountains to climb
[434] President – or patron

on the World Bank's ease of doing business survey[.]"[435] Strengthening its relationship with the Andean Development Bank – which "has interest in" developing solar power projects in the highlands near the nation's capital as well as "wind and biogas near Santa Cruz in the East"[436] – will provide further inroads to Latin American energy markets.

"Even if Bolivia's natural resources-driven economy can ride out the end of the commodities boom, government revenues from gas exports are on course to fall by 30% this year alone."[437]

And while Bolivian cooperation with the previously outlined corporations will go a long way in drawing attention from investors, much more will need to be done in order to engender faith in government's ability to stave-off further nationalization of international investments. At a conference hosted by Financial Times on October 26th, 2015 in New York City,[438] President Morales presented a governmental environment receptive to international investment in various sectors, from agriculture and energy production to the development of lithium reserves in the Salar de Uyuni. But the open-minded picture painted during the conference may not match the realities of Bolivian politics.

The president's claims of interest in development of all sectors at the conference are questioned due to the fact that breakout sessions were considered informal and "merely informational" by their attendees.[439] Observers also question President Morales' commitment to forming an assembly of international ambassadors in his cabinet, thereby prolonging the tenure of "four or five people that really run"[440] Bolivia, mimicking somewhat the Financial Times' special publication which contains a bevy of articles authored by a select few journalists.[441] These perceptions must be addressed if Bolivia is going to attract the international investment necessary for the construction of renewable energy generating facilities in the nation as being "pretty open to new ideas"[442] must translate into actionable policies.

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[435] Mountains to climb
[436] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[437] President – or patron
[438] The New Bolivia
[439] Escobar, Gabriel – DCM; Ballesteros Ferrel, Mauricio – Environment, Science, Technology and Health Specialist; del Carmen Palma, Olga – Information Specialist. U.S. Embassy, La Paz, Bolivia. 2.29.16
[440] Escobar, Gabriel – DCM; Ballesteros Ferrel, Mauricio – Environment, Science, Technology and Health Specialist; del Carmen Palma, Olga – Information Specialist. U.S. Embassy, La Paz, Bolivia. 2.29.16
[441] The New Bolivia
[442] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16

This may begin with the clarification of the state's governmental control over economic activities throughout the nation as President Morales and the MAS party insist the nation is strictly socialist while many observers argue that this is not the case. Several private sector industries have been boomed in recent years, particularly in Santa Cruz, the nation's economic hub – the "Bolivian government's economic strategy is simply state capitalism – a rentier model fueling populist measures."[443] Others assert their opinions in stronger language – "Do not call this socialism, please[…] Have some respect for Marx."[444] Either way, the MAS government must be clearer when presenting its message to international investors, including statements by energy minister Luis Alberto Sanchez such as – "We know the projections. I do not expect big problems."[445]

"Bolivia's economy remains heavily dependent on commodities, so the current decline in their prices raises the question of future sustainability."[446]

The president must also be amenable the recent progress made in the business world as it conforms to western ideals, such as equal rights for same-sex couples.[447] Furthermore, the Bolivian tradition of duality,[448] where men and women are equally represented in indigenous governance, is mirrored in the gender equality of the western world. Yet the president's "idea of an inclusive and equitable society is riddled with contradictions as he bypasses gender issues "– he sees women as subordinate to men[.]"[449] This is in addition to the development obstacles created by the national government's fear of "outside interests" in providing "many different layers" and "hoops to jump through" in order to receive the MAS party's approval for a given project.[450]

Fortunately, the "bureaucratization of social action"[451] feared by Escobar may be defeated by unhindered social media access coupled with the expansion of language-translating technologies, allowing for a greater exposure to international discourse in the nation. This could

[443] Upward mobility
[444] Upward mobility
[445] Power to the people
[446] Antsee, Margaret. Op-ed column.
[447] An influence too far
[448] Bolivia Global Field Intensive – 11.14.14, 11.15.14, 11.16.14
[449] An influence too far
[450] Healy, Kevin. Professor – George Washington University, Washington D.C. 2.8.16
[451] Escobar – Page 53

lead to a warming of the relationship between Bolivia and the United States which is decidedly estranged following the ouster of Ambassador Philip Goldberg in 2008.[452] Repairing this fragile bond will be of great benefit to the country. And while the "official governmental position" is decidedly anti-American, there are conversations "behind closed doors" that signal the nation will take foreign investment "from anywhere they can get it."[453]

Much like the installation of Telefericos in El Alto and La Paz,[454] BBDP aims to leapfrog the challenges posed by and mistakes made through traditional development methods. It does so using state-of-the-art technology in order to solidify NG reserves to meet growing domestic and international demand, stabilize aging electrical infrastructure, promote GHG emissions reductions and environmental conservation, and further strengthen Bolivia's relationship with international actors. The proposal can be just the beginning of a major energy transformation in the nation, similar to that of Germany's Energiewende,[455] as the cost of solar and wind energy generation continues to plummet[456] whilst protecting the delicate ecosystem of vast resources offered in the Salar de Uyuni.

By no means has humanity's progress come without cost – countless lives have been taken in the name of colonization, dominion, production, wealth, and beyond. Even more have been lost due to mankind's incapability to protect itself from catastrophe, whether it be due to climate change, disease, famine, or other. But adaptation, mitigation, and remediation are just some of the essential skills that the global society has developed via cooperation, debate, and exploration in the face of great peril; and the world stands ready to continue doing so. And with Pachamama in mind, Bolivia is poised to "ride out the effects of a global crisis"[457] by maintaining and promoting a unique model for sustainable development.

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[452] Bolivia expels US ambassador Philip Goldberg
[453] Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. 3.10.16
[454] La Paz's cable-car system Teleferico a heady ride that bridges Bolivia's values
[455] Energy Transition – The German Energiewende
[456] Global Trends in Renewable Energy Investment 2015
[457] An influence too far

8. Areas for Future Research

Of final concern for BBDP is the further exploration of relationships between indigenous populations and international actors, the sustainable development of previously-untapped Bolivian resources, and the expansion of renewable energy and climate change-abating technologies throughout the nation. The study of these topics poses challenges and opportunities whilst providing a multitude of arenas for the promotion of benefit or remediation in light of their individual result(s) in both academic and professional circles. The study of Bolivian economic and human development will only grow richer and more nuanced, over time.

Academic

A major component of BBDP is the further integration of indigenous peoples in the national economy. Because many of these Bolivians take part in non-traditional markets – studies estimate that "nine out of 10 new jobs in Bolivia are in the informal sector"[458] – there exists an inherent separation between ethnicities, marketplaces, urban and rural areas, and beyond. The inclusion of native languages such as Uru of the Uru-Chipaya tribe – a group numbering roughly 2,000 that relies on the dwindling water resources of the Lauca River for its survival[459] – in developmental tools such as BATTS may prevent the death of certain dialects and provide additional cultural exchange with other indigenous tribes as well as provide resources for the sustainability of their agrarian, non-migratory lifestyle.

It will be necessary to communicate to these groups the necessity for adaptation to changes in climate, but conservation of essential cultural elements must be prioritized in the process. Moreover, the surveying of BATTS members could provide additional tools from indigenous cultures for the prioritization of environmental conservation efforts in developed nations. Lastly, the study of cultural exchange in regions previously underserved by electrical capacity could prove fruitful for the study of linguistics whilst illuminating the ways in which the imparting of knowledge can be translated into modern structures. The American Society and Council of the Americas[460] could be a potential partner in such an endeavour.

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[458] Upwardly mobile
[459] Survival instincts
[460] American Society and Council of the Americas

Economic & Technical

Domestically, RNG derived from BBDP, along with other renewable sources of energy such as CSP, PV, and wind, should play a role in the development of lithium through the delivery of equipment to the Salar de Uyuni, powering industrial processes, and transporting the refined product to customers. As such, it will be necessary to investigate the expansion of Bolivia's NG network and the proposed Bolivia-Brazil NG pipeline[461] could provide for the increased exportation of RNG whilst preventing encroachment on profits from the high cost of international shipping, thereby alleviating the need for costly LNG importation.

As various AD technologies (e.g. activated sludge, filter, and lagoon units) behave differently in a given environment with a combination of feedstocks, the data generated by BBDP units could then be translated more rapidly to other emerging markets such the effects of RNG utilization on reducing localized pollution in high-altitude environments. This would be of great benefit to all countries, particularly in East Asia (e.g. Bangladesh, Indonesia, Malaysia, and Thailand) facing the threat of massive human migration due to climate change.[462]

One area of interest to BBDP that has yet to be explored is utilization of post-consumer siloxanes – a manmade, volatile organic compound often used in cosmetic and industrial production[463] – from Bolivian landfills. "Bolivia is making unprecedented investments in a suite of petrochemical plants" as the nation hopes to jumpstart "an industrial base formed on gas"[464] which could be bolstered by the compound as it must be removed from RNG prior to combustion.[465] The prevalence of the compound must first be measured as the nation's recent development dictates that its landfills may not contain the same levels of siloxanes as their counterparts in the United States.

[461] The Bolivia-to-Brazil Pipeline
[462] Borrowed Time on Disappearing Land
[463] Siloxanes
[464] Power to the people
[465] Siloxanes and Landfill Gas Utilization

9. About the Author

BBDP is submitted in fulfillment of the thesis requirement for the author's candidacy in M.S. in Global Affairs with a concentration in Environment & Energy Policy. He has previously argued for the expansion of Bolivia's renewable energy portfolio[466] as well as restraint in realizing its nuclear ambitions,[467] although he is a supporter of advanced nuclear technologies in developed nations.[468] He has written similar proposals[469] for the sustainable development of cities around the world[470] and hopes to continue working on the promotion of renewable energy, environmental conservation, and indigenous rights in South America.

10. Terminology

- AD – Anaerobic Digester/Digestion
- BATTS – Bolivian Academic and Technical Training Service
- BBDP – Bolivian Biogas Development Proposal
- BTU – British Thermal Unit
- CH4 – Methane
- CHP – Combined Heat and Power
- CNG – Compressed Natural Gas
- CO2 – Carbon Dioxide
- COP – Conference of the Parties
- CSP – Concentrating Solar Power
- CSR – Corporate Social Responsibility
- ED – Encountering Development: The Making and Unmaking of the Third World
- EGS – Enhanced Geothermal System
- EU ETS – European Union Emissions Trading System
- EV – Electric Vehicle
- FNPP – Food and Nutrition Policy and Planning
- GAES – German Academic Exchange Service
- g/MJ – Grams per Megajoule
- GIZ – German Society for International Cooperation
- GHG – Greenhouse Gas
- GMO – Genetically Modified Organism
- LNG – Liquefied Natural Gas
- MAS – Movimiento al Socialismo (Movement for Socialism)
- MMT – Million Metric Tons
- MSW – Municipal Solid Waste
- NG – Natural Gas
- NGO – Non-Governmental Organization
- NM3/h – Normal Meter Cubed per Hour
- PV – Photovoltaic

[466] The La Paz Personal Pollution Proposal
[467] A Fork in Bolivia's Energy Path
[468] Leave Them on the Ground
[469] Sustainable Energy for All Time
[470] The Luanda 2025 Proposal

- R&D – Research and Development
- RFS – Renewable Fuel Standard
- RIN – Renewable Identification Number
- RNG – Renewable Natural Gas
- SDG – Sustainable Development Goals
- SME – Small and Medium-sized Enterprises
- UN – United Nations
- YPFB – Yacimientos Petrolíferos Fiscales Bolivianos

11. Resources

Primary

Conferences, Interviews, & Meetings (In-person & mediated)

- Apaza, Bernardo; Pacara C., Hoved; Sandoval M., Felipe. Management team – El Ceibo Chocolate Company – La Paz, Bolivia. January 10th, 2015.
- Bodenschatz, Thomas. First Secretary – German Society for International Cooperation, German Embassy – La Paz, Bolivia. March 10th, 2016.
- Chapman, Katie. CleanWorld – Sacramento, California. July 23rd, 2015.
- Escobar, Gabriel – DCM; Ballesteros Ferrel, Mauricio – Environment, Science, Technology and Health Specialist; del Carmen Palma, Olga – Information Specialist. U.S. Embassy, La Paz, Bolivia. February 29th, 2016.
- Goletz, Mirko. Research Associate, Institute of Transport Research – Berlin, Germany. May 28th, 2015.
- Graf, Andreas. Researcher, Ecologic Institute – Berlin, Germany. March 23rd, 2016.
- Healy, Kevin. Professor – George Washington University, Washington D.C. February 8th, 2016.
- Anonymous employee, Layka Restaurant – La Paz, Bolivia.

Texts

- Escobar, Arturo. "Encountering Development: The Making and Unmaking of the Third World" Princeton University Press. Princeton, NJ. 1995. http://monoskop.org/images/1/1f/Escobar_Arturo_Encountering_Development_1995.pdf
- "The New Bolivia" Financial Times. October 27th, 2015. (Special edition)
    - Dunkerly, James. "Man of the people"
    - Rathbone, John Paul. "Mountains to climb"
    - Schipani, Andres. "President – or patron"
    - Schipani, Andres. "Upwardly mobile"
    - Antsee, Margaret. Op-ed column.
    - Wilson, James. "Power to the people"
    - Schipani, Andres. "Extra charge – salt flat stores battery power"
    - Wilson, James. "Kings of the hill"
    - Mander, Benedict. "Betting the farm"
    - Schipani, Andres. "Quinoa – Ancient superfood, modern success"
    - Schipani, Andres; Mander, Benedict. "Survival instincts"
    - Mander, Benedict. "Jungle Baroque"
    - Schipani, Andres. "Premium potential"

- Paz Soldan, Edmundo. “An influence too far”

Non-Scholastic

- Dick, Steven J. “The Importance of Exploration” NASA. https://www.nasa.gov/missions/solarsystem/Why_We_01pt1.html
- Michaelides, Efstathios E. Stathis. “Alternative Energy Sources” Springer. New York, New York. 2012. http://link.springer.com/book/10.1007%2F978-3-642-20951-2
- “Tesla Motors” https://www.teslamotors.com/
- Graham Richard, Michael. “Costa Rica hasn’t used any fossil fuels for electricity so far in 2015.” Treehugger. April 7th, 2015. http://www.treehugger.com/renewable-energy/costa-rica-hasnt-used-any-fossil-fuels-for-electricity-so-far-2015.html
- “What is Distributed Generation?” Bloom Energy. http://www.bloomenergy.com/fuel-cell/distributed-generation/
- “Thermal Energy Storage – Technology Brief (E17)” IRENA. January 2013. https://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20E17%20Thermal%20Energy%20Storage.pdf
- “Energy efficiency” International Energy Agency. https://www.iea.org/topics/energyefficiency/
- “The Emissions Gap Report” United Nations Environment Programme. November 2010. http://www.unep.org/publications/ebooks/emissionsgapreport/pdfs/EMISSION_GAP_REPORT_LOWRES.pdf
- “Diesel Particulate Matter” U.S. Environmental Protection Agency. https://www3.epa.gov/region1/eco/airtox/diesel.html
- “Fuel Blending: Capture the Potential of Non-Recyclable Waste” Veolia. http://www.veolianorthamerica.com/en/our-services/waste-recovery-services/fuel-blending
- “Renewable Fuels: Regulations & Standards” United States Environmental Protection Agency (EPA). http://www.epa.gov/oms/fuels/renewablefuels/regulations.htm
- Wang, Michael; Han, Jeongwoo; Dunn, Jennifer B.; Cai, Hao; Elgowainy, Amgad. “Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcanes, and cellulosic biomass for US use” Iop Publishing. December 13th, 2012. https://iopscience.iop.org/article/10.1088/1748-9326/7/4/045905
- Bryce, Robert. “The Hidden Corn Ethanol Tax – How Much Does the Renewable Fuel Standard Cost Motorists” Manhattan Institute for Policy Research. March 2015, Issue No. 32. http://www.manhattan-institute.org/pdf/ib_32.pdf
- “New Fuel Pathways” United States Environmental Protection Agency (EPA). http://www.epa.gov/otaq/fuels/renewablefuels/new-pathways/
- “Renewable Energy Sources and Climate Change Mitigation – Summary for Policymakers and Technical Summary” Working Group III – Intergovernmental Panel on Climate Change. 2011. https://www.ipcc.ch/pdf/special-reports/srren/SRREN_FD_SPM_final.pdf
- “Global Greenhouse Gas Emissions” U.S. Environmental Protection Agency. February 23rd, 2016. https://www3.epa.gov/climatechange/ghgemissions/global.html
- “What Is Technological Convergence?” Wise Geek. http://www.wisegeek.org/what-is-technological-convergence.htm

- Alvarez, Rene. "Anaerobic Digestion of Solid Residues on the Bolivian Altiplano" Lund University Press. https://lup.lub.lu.se/search/publication/547389
- Friedrich Ebert Foundation. La Paz, Bolivia. http://www.fes-bolivia.org/pages/inicio.php?lang=PT
- German-Bolivian Chamber of Commerce and Industry. German government. http://bolivien.ahk.de/es/
- Fox, Holly. Hallam, Mark. "German cabinet approves 2022 nuclear shutdown" DW. June 7th, 2011. http://www.dw.com/en/german-cabinet-approves-2022-nuclear-shutdown/a-15134028-1
- Eddy, Melissa. "Nuclear Plant Closing Reflects Overhaul of Germany Energy Production" The New York Times. July 12th, 2015. http://www.nytimes.com/2015/07/13/world/europe/nuclear-plant-closing-reflects-overhaul-of-german-energy-production.html?_r=0
- Amelang, Sören. "Germany's dependence on imported fossil fuels" Clean Energy Wire. February 11th, 2016. https://www.cleanenergywire.org/factsheets/germanys-dependence-imported-fossil-fuels
- "The Geothermal Exploration Project" ICEIDA. http://www.iceida.is/english/partner-countries/regional-cooperation/#
- Schmidt, Silke. "Rebecca Larson helps bring anaerobic digester systems to Uganda, Bolivia" College of Arts & Sciences News, College of Wisconsin-Madison. March 3rd, 2015. http://news.cals.wisc.edu/2015/03/03/rebecca-larson-helps-bring-anaerobic-digester-systems-to-uganda-bolivia/
- "Expression of interest to participate in the financing of the Scaling-up of Renewable Energy Program (SREP) in Low Income Countries" Climate Investment Funds. https://www-cif.climateinvestmentfunds.org/sites/default/files/meeting-documents/bolivia_eoi_0.pdf
- Cludius, Johanna; Forster, Hannah; Graichen, Verena. "Greenhouse Gas Mitigation in the European Union" World Resources Institute. November 2012. http://www.wri.org/publication/greenhouse-gas-mitigation-european-union
- "Renewable Energy – Biomass" European Commission. https://ec.europa.eu/energy/en/topics/renewable-energy/biomass
- "Renewable Energy – Biofuels" European Commission. https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels
- Luleva, Mila. "Cable Car Over La Paz to Solve City's Urban Traffic Pollution and Congestion" The Green Optimistic. April 14th, 2014. http://www.greenoptimistic.com/cable-car-la-paz-solve-citys-urban-traffic-pollution-congestion-20140414/
- "Status of Fuel Quality and Vehicle Emissions Standards: Latin America and the Caribbean" UN Environmental Programme. March 2012. http://www.unep.org/transport/pcfv/PDF/Maps_Matrices/LAC/matrix/LAC_combined_March2012.pdf
- Azzarello, Samantha. "Energy Price Spread: Natural Gas vs. Crude Oil in the US" CME Group. 2014. http://www.cmegroup.com/education/files/energy-price-spread-natural-gas-vs-crude-oil-in-the-us.pdf

- "Bolivia: over 27,000 vehicles where converted to natural gas in 2014" NGV Journal. January 19th, 2015. http://www.ngvjournal.com/bolivia-over-27000-vehicles-were-converted-to-natural-gas-in-2014/
- "Bolivian Government Supplies 200 CNG Engines for Santa Cruz Buses" NGV Global News. October 6th, 2014. http://www.ngvglobal.com/bolivian-government-supplies-200-cng-engines-for-santa-cruz-buses-1006
- "EU 2030 Goals" European Union. http://ec.europa.eu/energy/en/topics/energy-strategy/2030-energy-strategy
- "The EU Emissions Trading System (EU ETS)" Climate Action – European Commission. http://ec.europa.eu/clima/policies/ets/index_en.htm
- Neslen, Arthur. "EU set to emit 2bn tonnes more CO2 than Paris climate pledge" The Guardian. February 29th, 2016. http://www.theguardian.com/environment/2016/feb/29/eu-set-to-emit-2bn-tonnes-more-co2-than-paris-climate-pledge
- Fendt, Lindsay. "The truth behind Costa Rica's renewable energy" The Guardian. March 30th, 2015. http://www.theguardian.com/commentisfree/2015/mar/30/truth-behind-costa-rica-renewable-energy-reservoirs-climate-change
- Kiernan, Paul. "Brazil's Petrobras Reports $17 Billion in Asset and Corruption Charges" The Wall Street Journal. April 22nd, 2015. http://www.wsj.com/articles/brazils-petrobras-reports-nearly-17-billion-impairment-on-assets-corruption-1429744336
- "How an Enhanced Geothermal System Works" U.S. Department of Energy. http://energy.gov/eere/geothermal/how-enhanced-geothermal-system-works
- "Brazil Increases Natural Gas Imports from Bolivia to Restart Power Plant" Platts. April 17th, 2014. http://www.platts.com/latest-news/natural-gas/riodejaneiro/brazil-increases-natural-gas-imports-from-bolivia-21502965
- "Global Trends in Renewable Energy Investment 2015" Frankfurt School; Bloomberg New Energy Finance. 2015. http://fs-unep-centre.org/sites/default/files/attachments/key_findings.pdf
- "Anaerobic Digestion – Case Studies" Biogas Info. http://www.biogas-info.co.uk/ad-case-studies.html
- Dodge, Edward. "How Much Renewable Natural Gas Can Be Produced" Breaking Energy. December 18th, 2014. http://breakingenergy.com/2014/12/18/how-much-renewable-natural-gas-can-be-produced/
- "An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities" U.S. Department of Agriculture. October 2007. http://www.agmrc.org/media/cms/manuredigesters_FC5C31F0F7B78.pdf
- "Solar Electricity Cost" Solar Cell Central. http://solarcellcentral.com/cost_page.html
- Wilson, Simon. "What's Driving Bolivia's Booming Economy?" The Mises Institute. July 2nd, 2015. https://mises.org/library/what%E2%80%99s-driving-bolivia%E2%80%99s-booming-economy
- Spence, Peter. "Oil price rout sends inflation to lowest levels witnessed since Great Depression" The Telegraph. December 19th, 2015. http://www.telegraph.co.uk/finance/economics/12058680/Oil-price-rout-sends-inflation-to-lowest-levels-witnessed-since-Great-Depression.html

- "Energy Outlook 2035" BP. http://www.bp.com/en/global/corporate/about-bp/energy-economics/energy-outlook.html
- "World Energy Outlook 2015 – Executive Summary" International Energy Agency. November 2015. https://www.iea.org/publications/freepublications/publication/WEB_WorldEnergyOutlook2015ExecutiveSummaryEnglishFinal.pdf
- "International Energy Outlook – Overview" U.S. Energy Information Agency. September 9th, 2014. http://www.eia.gov/forecasts/ieo/
- Disparte, Dante Alighieri. "Bad Things Happen in the Dark" December 12th, 2014. http://www.internationalpolicydigest.org/2014/12/12/bad-things-happen-dark/
- Woody, Christopher. "Chile and Bolivia are still arguing over the outcome of a war they fought 131 years ago" Business Insider. October 4th, 2015. http://www.businessinsider.com/chile-bolivia-sea-access-land-dispute-2015-10
- "Renewable Natural Gas – Clean Green Energy" Energy Vision. http://energy-vision.org/fact-sheets/Renewable-Natural-Gas-Clean-Green-Energy-Infographic.pdf
- Levin, Julia; Mitchell, Katherine; Swisher, Henry. "Why California Needs A Renewable Fuel Gas Standard" Bioenergy Association of California. November 2014. https://www.americanbiogascouncil.org/pdf/BAC%20Report%20on%20Renewable%20Gas%20Standard.pdf
- "Landfill Gas Power Plants" California Energy Commission. http://www.energy.ca.gov/biomass/landfill_gas.html
- Casey, Tina. "Saving the World, One Sewage Treatment Plant at a Time" Clean Technica. May 4th, 2010. http://cleantechnica.com/2010/05/04/saving-the-world-one-sewage-treatment-plant-at-a-time/
- Zissis, Carin. "Bolivia's Nationalization of Oil and Gas" Council on Foreign Relations. May 12th, 2006. http://www.cfr.org/world/bolivias-nationalization-oil-gas/p10682
- "Renewable Natural Gas for Transportation: An Overview of the Feedstock Capacity, Economics, and GHG Emission Reduction Benefits of RNG as a Low-Carbon Fuel" NPC Future Transportation Fuels Study. August 1st, 2012. http://www.npc.org/ftf_topic_papers/22-rng.pdf
- "Full Fuel Cycle Assessment: Well-to-Wheels Energy Inputs, Emissions, and Water Impacts" TIAX for the California Energy Commission. June 2007. http://www.energy.ca.gov/2007publications/CEC-600-2007-004/CEC-600-2007-004-F.PDF
- "Energy 101: Promoting Energy Education in the Nation's Colleges and Universities" U.S. Department of Energy. http://energy.gov/eere/education/articles/energy-101-promoting-energy-education-nation-s-colleges-and-universities
- "Bolivia's YPFB: $3 bn invested in exploration projects" Fox News Latino. August 15th, 2014. http://latino.foxnews.com/latino/news/2014/08/15/bolivia-ypfb-3-bn-invested-in-exploration-projects/
- "Global Inequality" Institute for Policy Studies. http://inequality.org/global-inequality/
- "Law of Mother Earth – The Rights of Our Planet – A Vision from Bolivia" World Future Fund. http://www.worldfuturefund.org/Projects/Indicators/motherearthbolivia.html

- Becker, Sarah. "The Effects of the Drug Cartels on Medellin and the Colombian State" Brandeis University. May 2013. https://bir.brandeis.edu/bitstream/handle/10192/25053/BeckerThesis2013.pdf?sequence=1
- Mignolo, Walter D.; Escobar, Arturo. "Globalization and the Decolonial Option" Routledge. Oxon, UK. 2010. https://books.google.com/books/about/Globalization_and_the_Decolonial_Option.html?id=xkeOAQAAQBAJ&printsec=frontcover&source=kp_read_button&hl=en#v=onepage&q&f=false
- De Swart, Bart. "Indigenous Power: Renewable electricity and sustainability in Mexico and South America" University of London. August 28th, 2012.
- Hargreaves, Lucy C. "The Whole-School Approach to Education for Sustainable Development: From Pilot Projects to Systemic Change" Centre for Global Education. Issue 6, 2008. http://www.developmenteducationreview.com/issue6-perspectives2
- Spracklen, Dominick V. "Global warming: China's contribution to climate change" Nature. March 17th, 2016. http://www.nature.com/nature/journal/v531/n7594/full/531310a.html
- "The Four System Conditions of a Sustainable Society" The Natural Step. http://www.thenaturalstep.org/sustainability/the-system-conditions/
- "Decoupling of global emissions and economic growth confirmed" International Energy Agency. March 16th, 2016. https://www.iea.org/newsroomandevents/pressreleases/2016/march/decoupling-of-global-emissions-and-economic-growth-confirmed.html
- "50 Years of Moore's Law" intel. https://www-ssl.intel.com/content/www/us/en/silicon-innovations/moores-law-technology.html
- "Global natural gas consumption doubled from 1980 to 2010" U.S. Energy Information Agency. April 12th, 2012. https://www.eia.gov/todayinenergy/detail.cfm?id=5810
- Singham, Nate. "Bolivian Independence from the World Bank and IMF" Telesur. April 17th, 2015. http://www.telesurtv.net/english/analysis/Bolivian-Independence-from-the-World-Bank-and-IMF--20150416-0017.html
- Hill, David. "Is Bolivia going to frack 'Mother Earth'?" The Guardian. February 24th, 2015. http://www.theguardian.com/environment/andes-to-the-amazon/2015/feb/23/bolivia-frack-mother-earth
- "The Economics of Unconventional Gas Extraction Projects" Unconventional Gas in Ukraine. April 14th. 2014. http://shalegas.in.ua/en/ekonomika-proektiv-vydobuvannya-netradytsijnogo-gazu/
- Beattie, Andrew. "The Cost of Shale Oil Versus Conventional Oil" Investopedia. http://www.investopedia.com/articles/active-trading/051215/cost-shale-oil-versus-conventional-oil.asp
- Manning, John. "Fracking – A Bubble Waiting to Burst?" International Banker. http://internationalbanker.com/comment/fracking-bubble-waiting-burst/
- Jones, Corey. "Mounting evidence says injection wells cause Oklahoma's earthquake surge" Tulsa World. June 4th, 2015. http://www.tulsaworld.com/news/state/mounting-evidence-says-injection-wells-cause-oklahoma-s-earthquake-surge/article_bf9a2055-01de-5b26-914e-48dac5c0eded.html

- "What Chemicals Are Used" FracFocus. 2016. https://fracfocus.org/chemical-use/what-chemicals-are-used
- Aplin, Stephen E. "The cost of energy: a comparison of fuels in Ontario" Canadian Energy Issues. February 9th, 2015. http://canadianenergyissues.com/2015/02/09/the-cost-of-energy-a-comparison-of-fuels-in-ontario/
- Wickberg, Sofia. "Overview of corruption and anti-corruption in Bolivia" U4 Anti-Corruption Resource Center. September 27th, 2012. http://www.u4.no/publications/bolivia-overview-of-corruption-and-anti-corruption/downloadasset/3052
- "Radiative Forcing of Climate" UN IPCC. https://www.ipcc.ch/ipccreports/far/wg_I/ipcc_far_wg_I_chapter_02.pdf
- Froggatt, Antony; Schneider, Mycle. "Nuclear Power Versus Renewable Energy – A Trend Analysis" Institute of Electrical and Electronics Engineers. April 4th, 2015. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7110436
- Wilson, Robert. "Why Germany's Nuclear Phaseout is Leading to More Coal Burning" The Energy Collective. January 20th, 2014. http://theenergycollective.com/robertwilson190/328841/why-germanys-nuclear-phase-out-leading-more-coal-burning
- "YPFB y Petrobras firmaran un convenio" Pagina Siete. April 11th, 2016. http://www.paginasiete.bo/economia/2016/4/11/ypfb-petrobras-firmaran-convenio-92802.html
- Suurkula M.D., Jaan. "Genetically Engineered Crops – A Threat to Soil Fertility?" Physicians and Scientists for Responsible Application of Science and Technology. December 14th, 2010. http://www.psrast.org/soilecolart.htm
- Garfi, Marianna. "Psychrophilic anaerobic digestion of guinea pig manure in low-cost tubular digesters at high altitude" Bioresource Technology. Volume 102, Issue 10. May 2011. http://www.sciencedirect.com/science/article/pii/S0960852411003464
- Khachatryan, Hayk; Casavant, Ken; Jessup, Eric; Frear, Craig. "Economic Feasibility Assessment for Renewable Fertilizers from Anaerobic Digestion with Integrated Manure Nutrient Recovery System" Washington State University. Frankfurt, Germany, June 20th to 23rd, 2011. http://ses.wsu.edu/wp-content/uploads/2015/03/FPTI-present_Jessup-fertilizer.pdf
- "Agriculture – Cool The Planet. Feed The World." Regeneration International. http://regenerationinternational.org/agriculture/
- "Organic farming offers higher profits with challenges" The Organic and Non-GMO Report. June 2006. http://www.non-gmoreport.com/articles/jun06/organic_farming.php
- Spector, Kaye. "10 Urban Farming Projects in New York City" EcoWatch. November 8th, 2013. https://ecowatch.com/2013/11/08/urban-farming-projects-new-york-city/
- "Kalundborg Symbiosis is the world's first working industrial symbiosis." Kalundborg Symbiosis. http://www.symbiosis.dk/en
- Harris, Steve; van Berkel, Rene; Kurup, Biji. "Fostering Industrial Symbiosis for Regional Sustainable Development Outcomes" Center of Excellence in Cleaner Production – Curtin University. 2008. https://www.researchgate.net/publication/228361252_Fostering_Industrial_Symbiosis_for_Regional_Sustainable_Development_Outcomes

- "Sustainable Development Goals" United Nations. https://sustainabledevelopment.un.org/?menu=1300
- "The Case for Crop Feedstocks in Anaerobic Digestion" ADBA, CLA, NFU, and REA. November 2011. http://adbioresources.org/wp-content/uploads/2012/09/120730-PGC-Briefing-Doc.pdf
- Usi, Eva. "TIPNIS: mas que un conflicto por una carretera" DW. January 8th, 2015. http://www.dw.com/es/tipnis-m%C3%A1s-que-un-conflicto-por-una-carretera/a-16506622
- Dodge, Edward. "Renewable Natural Gas Helps Reduce Emissions, Policy Support Needed" Breaking Energy. December 5th, 2014. http://breakingenergy.com/2014/12/05/renewable-natural-gas-helps-reduce-emissions-policy-support-needed/
- "Bolivia – Background" U.S. Energy Information Administration. https://www.eia.gov/beta/international/analysis.cfm?iso=BOL
- Von Mettenheim, Kurt; Del Tedesco Lins, Maria Antonieta. "Government Banking – New Perspectives on Sustainable Development and Social Inclusion from Europe and South America" Konrad Adenauer Foundation. 2008. https://www.academia.edu/164330/Government_Banking_New_Perspectives_on_Sustainable_Development_and_Social_Inclusion_from_Europe_and_South_America
- Tisdell, Prof. Clement A. "Economics of Environmental Conservation – 2nd Edition" Elgar. 2007. http://www.e-elgar.com/shop/economics-of-environmental-conservation-second-edition
- El Ceibo Chocolate Company. El Alto, Bolivia. http://elceibo.com/ceibo/en/index.php
- "Combined heat and power (CHP) plants" Caterpillar Energy Solutions. http://www.mwm.net/mwm-chp-gas-engines-gensets-cogeneration/combined-heat-power-chp-plant/
- "Bolivia – Situation and Cooperation" Ministry for Economic Cooperation and Development, German Government. http://www.bmz.de/en/what_we_do/countries_regions/lateinamerika/bolivien/cooperation.html
- KfW Bank of Responsibility. https://www.kfw.de/kfw.de-2.html#
- "European renewable energy incentive guide – Germany" Norton Rose Fulbright. January 2013. http://www.nortonrosefulbright.com/knowledge/publications/66180/european-renewable-energy-incentive-guide-germany
- "R&D Incentives – Germany's High-Tech Strategy" Germany Trade and Invest. http://www.gtai.de/GTAI/Navigation/EN/Invest/Business-location-germany/RD-framework/rd-incentives.html
- Germany Trade and Invest. http://www.gtai.de/GTAI/Navigation/EN/welcome.html#trade
- "Taxes and incentives for renewable energy" KPMG International. September 2013. https://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/taxes-and-incentives-for-renewable-energy/Documents/taxes-and-incentives-for-renewable-energy-2013.pdf

- "Taxation Papers – A Study on R&D Tax Incentives – Final Report" European Commission. Paper #52 – 2014. https://ec.europa.eu/futurium/en/system/files/ged/28-taxud-study_on_rnd_tax_incentives_-_2014.pdf
- "Maximum load fermentation for best gas yields" Agraferm Technologies. http://www.agraferm.com/en/technology/high-load-fermentation.html
- Ott, Markus. "Gas-to-Grid: Biogas Upgrading Technology" Agraferm Technologies. February 24th, 2016. http://www.handelskammer.dk/fileadmin/ahk_daenemark/Veranstaltungen/Bioenergi/14-20160301-Agraferm-AHK-journey-DK-15min.pdf
- "Natural gas as fuel internationally and in Germany" E. On. http://www.eon.com/en/business-areas/sales/mobility/gas-mobility.html
- "Siemens Gas Turbines – Gas turbines with a capacity from 4 to 400 MW" http://www.energy.siemens.com/hq/en/fossil-power-generation/gas-turbines/
- "E.ON Gas Storage operates 15 underground gas storage facilities" E.On. http://www.eon.com/en/business-areas/gas-storage-and-transport/underground-storage-facilities/storage-facility-operators-in-germany.html
- "Renewable Energy – Support schemes" European Commission. https://ec.europa.eu/energy/en/topics/renewable-energy/support-schemes
- Darby, Megan. "Germany and Austria call for higher EU 2030 climate ambition" The Guardian. March 4th, 2016. http://www.theguardian.com/environment/2016/mar/04/germany-and-austria-call-for-higher-eu-2030-climate-ambition
- Moletta, Rene. "ANAEROBIC DIGESTION – Monitoring and Control" Laboratoire de Biotechnologie de l'Environement. http://www.moletta-methanisation.fr/articles/commande/commande_automatique_98.pdf
- Hristova, Diana. "Bolivia's Guabira sugar mill considers new 15MW – report" SeeNews Renewables. October 16th, 2015. http://renewables.seenews.com/news/bolivias-guabira-sugar-mill-considers-new-15-mw-report-497758#
- "Biogas Capture and Utilization: An Effective, Affordable Way to Reduce Greenhouse Gas Emissions and Meet Local Energy Needs" Environmental and Energy Study Institute. June 2009. http://www.eesi.org/files/biogas_issuebrief_061609.pdf
- "Many years of experience in waste pre-processing and recycling" Agraferm Technologies. http://www.agraferm.com/en/technology/waste-treatment.html
- Denis, Isabelle. "One third of all food wasted!" Regional Information Centre for Western Europe, United Nations. http://www.unric.org/en/food-waste/27133-one-third-of-all-food-wasted
- Hipermaxi S.A. http://www.hipermaxi.com/
- Cervecería Boliviana Nacional S.A. http://www.cbn.bo/
- "Implementing Waste-to-Biogas in Bolivia – Summary for Policy Makers" Unit of Energy and Climate Studies, KTH Royal Institute of Technology. July 15th, 2015. http://carbonn.org/uploads/tx_carbonndata/D21_Strategies%20to%20implement%20biogas%20in%20Bolivia%20Summary%20for%20Policy%20Makers%20July%202014.pdf
- Alvarez, R.; Lidén, G. "The effect of temperature variation on biomethanation at high altitude." Bioresour Technol. February 8th, 2007. https://www.ncbi.nlm.nih.gov/pubmed/18262414

- "The Potential Benefits of Distributed Generation and Rate-Related Issues That May Impede Their Expansion" U.S. Department of Energy. February 2007. https://www.ferc.gov/legal/fed-sta/exp-study.pdf
- Bodzin, Steven. "Why are my lungs burning (Part 4, La Paz edition)" Setty's notebook. July 3rd, 2011. https://settysoutham.wordpress.com/2011/07/03/why-are-my-lungs-burning-part-4-la-paz-edition/
- "Poverty Reduction Strategy Paper" Republic of Bolivia. La Paz, Bolivia. March 2001. https://www.imf.org/external/NP/prsp/2001/bol/01/033101.pdf
- Shahriari, Sarah. "Lake Titicaca: Can Small Communities Fight Big Cities that Pollute?" Pulitzer Center. March 2nd, 2012. http://pulitzercenter.org/reporting/bolivia-environment-water-pollution-protests-communities-pallina-river-lake-titicaca
- Beniston, Martin. "Climate change in mountain regions: a review of possible impacts" University of Fribourg. May 31st, 2003. http://doc.rero.ch/record/4901/files/1_beniston_ccm.pdf
- Navaratnasamy, Mahendran; Edeogu, Ike; Papworth, Lawrence. "Economic Feasibility of Anaerobic Digesters" Alberta Agricutlure & Forestry. October 16th, 2015. http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/agdex12280
- "Anaerobic Digesters" Alberta Agriculture and Forestry. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex10945
- "Waste-to-Biogas in Bolivia – Promoting Sustainable Development" Unit of Energy and Climate Studies, KTH Royal Institute of Technology. July 15th, 2015. https://www.kth.se/polopoly_fs/1.338378!/Menu/general/column-content/attachment/Project%20summary%20Waste-to-biogas%20in%20Bolivia.pdf
- Aue, Gabriela. "The Possibilities for Biogas in Bolivia: Symbioses Between Generators of Organic Residue Biogas Producers and Biogas Users" KTH Royal Institute of Technology. September 2010. http://kth.diva-portal.org/smash/get/diva2:431737/FULLTEXT01.pdf
- "Bolivia – Climate change, poverty and adaptation" Oxfam. October 2009. https://www.oxfam.org/sites/www.oxfam.org/files/file_attachments/bolivia-climate-change-adaptation-0911_4.pdf
- "Bolivia's Morales blames capitalism for climate change" Al Jazeera. October 13th, 2015. http://www.aljazeera.com/news/2015/10/bolivia-morales-blames-capitalism-climate-change-151013084626123.html
- "Biogas Potential in the United States" Nation Renewable Energy Laboratory. October 2013. http://www.nrel.gov/docs/fy14osti/60178.pdf
- "Competition in Natural Gas Transportation? Technical and Economic Fundamentals and an Application to Germany" EFET Deutschland. Dresden, Germany. July 2007. http://www.efet-d.org/Cms_Data/Contents/EFETDeutschlandDatabase/Folders/Documents/Verschiedenes/EFET-Veroffentlichungen/~contents/79E2BWTQJCHHALBF/competition_gas_transmission_final.pdf
- Velasquez Donaldson, Christian. "Analysis of the Hydrocarbon Sector in Bolivia" Lambert Academic Publishing. 2012.

- "Gas – TransBoliviano Natural Gas Pipeline" AECOM. http://www.aecom.com/bo/projects/gas-transboliviano-natural-gas-pipeline-environmentalcultural-management-program/
- "Bolivia – Frontier country report" Deutsche Bank Research. November 12th, 2015. https://www.dbresearch.de/PROD/DBR_INTERNET_EN-PROD/PROD0000000000375400/Bolivia.pdf
- Ministry of Foreign Affairs. Bolivian government. http://www.cancilleria.gob.bo/webmre/
- Ministry of Hydrocarbons and Energy. Bolivian Government. http://www2.hidrocarburos.gob.bo/
- Ministry of Public Works, Services, and Housing. Bolivian government. http://www.oopp.gob.bo/
- Ministry of Productive Development and Plural Economy. Bolivian government. http://www.produccion.gob.bo/
- Yacimientos Petrolíferos Fiscales Bolivianos (YPFB). Bolivian Government. http://www.ypfb.gob.bo/es/
- Weiland, P. "Status of Biogas Upgrading in Germany" Johann Heinrich von Thünen-Institute. http://www.iea-biogas.net/files/daten-redaktion/download/publications/Workshops/2/Weiland_vienna.pdf
- "German Development Cooperation in the Sanitation Sector" Ministry for Economic Cooperation and Development, German Government. February 2009. http://www.bmz.de/en/publications/archiv/type_of_publication/strategies/spezial157.pdf
- "European Commission – International Cooperation and Development" European Union. https://ec.europa.eu/europeaid/home_en
- "Renewable energy directive" European Commission. https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive
- Cahoon, Ben. "Bolivia – Chronology" World Statesmen. http://www.worldstatesmen.org/Bolivia.html
- "Ethnic Germans in Bolivia" Project Gutenberg. http://gutenberg.us/articles/ethnic_germans_in_bolivia
- "Bolivia – German missions" Federal Foreign Office, German Government. http://www.auswaertiges-amt.de/EN/Laenderinformationen/01-Laender/DeutscheAVen/Bolivien/DeutscheVertretungen_node.html
- German Society for International Cooperation. https://www.giz.de/en/html/index.html
- "Products and expertise" GIZ Technical Agency – German Society for International Cooperation. https://www.giz.de/en/ourservices/range_of_services.html
- German Development Cooperation. German Embassy – La Paz, Bolivia. http://www.la-paz.diplo.de/
- Ministry of Economic Affairs and Energy. German Government. Berlin, Germany. https://www.bmwi.de/EN/Service/contact.html
- "The Federal Environment Ministry" Ministry for the Environment, Nature Conservation, and Nuclear Safety, German Government. Berlin, Germany. http://www.bmub.bund.de/en/
- "DRAFT Comparative Assessment of Technology Options for Biogas Clean-Up" California Biomass Collaborative. October 2014.

http://biomass.ucdavis.edu/files/2015/10/Biogas-Cleanup-Report_FinalDraftv3_12Nov2014-2.pdf

- "Your partner for economical AD plants" Agraferm Technologies. Germany. http://www.agraferm.com/en/home.html
- GASCADE Gastransport. https://www.gascade.de/en/
- "Feed-In of Biogas" GASCADE Gastransport. https://www.gascade.de/en/network-access/biogas/
- Gasunie Deutschland. http://www.gasunie.de/en/main-menu/company/gasunie-deutschland
- "Natural gas mobility – Fuelled for the future" E.On. http://www.eon.com/content/dam/eon-com/en/downloads/b/Brochure_EON_Natural_gas_mobility.pdf
- HZI BioMethan. http://www.hzi-biomethan.com/
- Schwarting Biosystem GmbH. Germany. http://www.schwarting-biosystem.de/index_en.php
- Siemens. http://www.energy.siemens.com/hq/en/fossil-power-generation/gas-turbines/
- "Sustainability – Siemens" Siemens. https://www.siemens.com/about/sustainability/en/
- TUBA Turbine. http://tubaturbine.de/en/
- "Plurinational State of Bolivia" External Action, European Union. http://eeas.europa.eu/bolivia/index_en.htm
- "DOEN Foundation" http://www.doen.nl/web/about-DOEN/About-the-DOEN-Foundation.htm
- Konrad Adenauer Foundation. La Paz, Bolivia. http://www.kas.de/bolivien/es/
- "Ecologic Institute: Science and Policy for a Sustainable World" Ecologic Institute. http://www.ecologic.eu/
- Bolivian Sustainable Development Hub. La Paz, Bolivia. http://www.bsdhub.org/
- German Academic Exchange Service. https://www.daad.de/en/
- Heinrich Böll Foundation. https://www.boell.de/en/contact
- "Landfill Gas Power Plants" California Energy Commission. http://www.energy.ca.gov/biomass/landfill_gas.html
- "United Nations Development Programme (UNDP) – Bolivia" United Nations. http://www.globalhand.org/en/organisations/22824
- Newman, Alex. "As UN Orders Expanded Global Drug War, Critics Fight Back" The New American. March 15th. 2013. http://www.thenewamerican.com/world-news/europe/item/14792-as-un-orders-expanded-global-drug-war-critics-fight-back
- "World Bank – Bolivia" World Bank. http://www.worldbank.org/en/country/bolivia
- Rich, Bruce. "Foreclosing the Future: The World Bank and the Politics of Environmental Destruction" Island Press. 2013.
- Lappe, Anna. "World Bank wants water privatized, despite risks" Al Jazeera America. April 17th, 2014. http://america.aljazeera.com/opinions/2014/4/water-managementprivatizationworldbankgroupifc.html
- Institute for Advanced Sustainability Studies. Berlin, Germany. http://www.iass-potsdam.de/en/people/dr-rainer-quitzow
- Institute for Transport Research. German Government. http://www.dlr.de/vf/en/

- "Bolivia – Background" Marcon International. http://www.marcon.com/print_index.cfm?SectionGroupsID=51&PageID=366
- Moriarty, Kristi. "Feasibility Study of Anaerobic Digestion of Food Waste in St. Bernard, Louisiana" National Renewable Energy Laboratory. January 2013. http://www.nrel.gov/docs/fy13osti/57082.pdf
- "Agriculture – value added (% of GDP) in Bolivia" Trading Economics. http://www.tradingeconomics.com/bolivia/agriculture-value-added-percent-of-gdp-wb-data.html
- "Cow Power Fun Facts" Energy Vision. http://energy-vision.org/fact-sheets/Cow-Power-Fun-Facts.pdf
- "Development Bank of Latin America" http://www.caf.com/en
- Ministry of Rural Development and Land. Bolivian government. http://www.agrobolivia.gob.bo/
- "Energy 101: Energy Efficient Commercial Buildings" U.S. Department of Energy. http://energy.gov/eere/videos/energy-101-energy-efficient-commercial-buildings
- "Energy 101: Daylighting" U.S. Department of Energy. http://energy.gov/eere/videos/energy-101-daylighting
- Murray, Brian C.; Galik, Christopher K.; Vegh, Tibor. "Biogas in the United States – An Assessment of Market Potential in a Carbon-Constrained Future" Duke University. February 2014. https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_r_14-02_full_pdf.pdf
- "Recommendations to the California Public Utilities Commission Regarding Health Protective Standards for the Injection of Biomethane into the Common Carrier Pipeline" California Air Resources Board; Office of Health Hazard Assessment. May 15th, 2013.
- Marcacci, Silvio. "Think Green Jobs Can't Grow? 6.5 Million Workers Think You're Wrong." Clean Technica. May 12th, 2014. http://cleantechnica.com/2014/05/12/think-green-jobs-cant-grow-6-5-million-workers-think-youre-wrong/
- Editors. "The Project: Manzana Wind Power Project Creates Renewable Energy and Local Jobs" Renewable Energy World. December 24th, 2014. http://www.renewableenergyworld.com/rea/news/article/2014/12/the-project-manzana-wind-power-project-creates-renewable-energy-and-local-jobs
- "The optimal heat recovery concept for biogas plants" MaxBiogas. http://www.maxbiogas.com/pdf/en/MBG_flyer_wp_1_The%20optimal%20heat%20recovery%20concept.pdf
- LaMonica, Martin. "Richard Branson and NRG test clean microgrid on private island" GreenBiz. February 6th, 2014. http://www.greenbiz.com/blog/2014/02/06/richard-branson-island-sets-pace-renewable-microgrids
- "Biogas Technology in Bolivia (Region Cochabamba)" Energypedia. https://energypedia.info/wiki/Biogas_Technology_in_Bolivia_(Region_Cochabamba)
- Bolivian-German Cultural Institute of Sucre. http://www.icba-sucre.edu.bo/ICBA2010/ICBA2010/es/Startseite.html
- Gamble, Kevin James. "Anaerobic Digestion from the Laboratory to the Field: An Experimental Study into the Scalability of Anaerobic Digestion" Appalachian State University. August 2014. https://libres.uncg.edu/ir/asu/f/Gamble,%20Kevin_2014_%20Thesis.pdf

- Donovan, John. "The battle for the Salar de Uyuni" Mother Nature Network. October 2nd, 2015. http://www.mnn.com/earth-matters/wilderness-resources/stories/battle-salar-de-uyuni
- "Powerwall – Tesla Home Battery" Tesla. http://www.teslamotors.com/powerwall
- McDonald, Michael. "BMW Going All-Electric" OilPrice.com. September 14th, 2015. http://oilprice.com/Energy/Energy-General/BMW-Going-All-Electric.html
- "Transportation's Role in Climate Change – Transportation and Greenhouse Gas Emissions" Transportation and Climate Change Clearinghouse, U.S. Department of Transportation. http://climate.dot.gov/about/transportations-role/overview.html
- Jönsson, O. "Biogas upgrading and use as transport fuel" Swedish Gas Centre. http://www.iea-biogas.net/files/daten-redaktion/download/publications/Workshops/7/06%20biogasupgrading.pdf
- "Bolivia Begins New Diesel to CNG Transit Bus Conversion Project" September 9th. 2015. http://www.ngvglobal.com/blog/bolivia-begins-new-diesel-to-cng-transit-bus-conversion-project-0909
- "Renewable Natural Gas (RNG) – A Clean, Secure, Commercially Viable Replacement for Diesel Fuel Today" Energy Vision. http://energy-vision.org/resources/fact-sheets/
- "RFS Voluntary Quality Assurance Plans" United States Environmental Protection Agency. http://www.epa.gov/oms/fuels/renewablefuels/qap.htm
- Kyriakopoulos, Michail. "REACT4C – Reducing Emissions from Aviation by Changing Trajectories for the Benefit of Climate" Transport Projects – Research & Innovation – European Commission. http://ec.europa.eu/research/transport/projects/items/react4c_en.htm
- "Economic incentives to mitigate greenhouse gas emissions from air transport in Europe" CE Delft. July 2002. http://ec.europa.eu/transport/modes/air/studies/doc/environment/2002_11_gas_emission_en.pdf
- Lengel, Allan. "Grease Guzzlers" The Washington Post. July 1st, 2006. http://www.washingtonpost.com/wp-dyn/content/article/2006/06/30/AR2006063001765.html
- Persson, Margareta; Jönsson, Owe; Wellinger, Arthur. "Biogas Upgrading to Vehicle Fuel Standards and Grid Injection" IEA Bioenergy December 2006. http://www.iea-biogas.net/files/daten-redaktion/download/publi-task37/upgrading_report_final.pdf
- Turner, Michael; Kooshian, Chuck; Winkelman, Steve. "Case Study: Colombia's Bus Rapid Transit (BRT) Development And Expansion" Mitigation Action Implementation Network. January 2012. http://www.ccap.org/docs/resources/1080/Colombia-case%20study-final.pdf
- Böckers, Veit; Heimeshoff, Ulrich; Müller, Andrea. "Pull-Forward Effect in the German Car Scrappage Scheme: A Time Series Approach" Heinrich Heine University. June 2012. http://www.dice.hhu.de/fileadmin/redaktion/Fakultaeten/Wirtschaftswissenschaftliche_Fakultaet/DICE/Discussion_Paper/056_Boeckers_Heimeshoff_Mueller.pdf
- McDermott, Jeremy. "Bolivia expels US ambassador Philip Goldberg" The Telegraph. September 12th, 2008. http://www.telegraph.co.uk/news/worldnews/southamerica/bolivia/2801579/Bolivia-expels-US-ambassador-Philip-Goldberg.html

- MacGregor, Hilary. "La Paz's cable-car system Teleferico a heady ride that bridges Bolivia's values" The Los Angeles Times. December 12th, 2015. http://www.latimes.com/travel/la-tr-d-bolivia-teleferico-20151213-story.html
- "Energy Transition – The German Energiewende" Heinrich Böll Foundation. http://energytransition.de/
- American Society and Council of the Americas. La Paz, Bolivia. http://www.as-coa.org/region/bolivia
- "The Bolivia-to-Brazil Pipeline" Center for Energy Economics, The University of Texas at Austin. http://www.beg.utexas.edu/energyecon/new-era/case_studies/Bolivia_to_Brazil_Pipeline.pdf
- Harris, Gardiner. "Borrowed Time on Disappearing Land" The New York Times. March 28th, 2014. http://www.nytimes.com/2014/03/29/world/asia/facing-rising-seas-bangladesh-confronts-the-consequences-of-climate-change.html?_r=0
- "Siloxanes" David Suzuki Foundation. http://davidsuzuki.org/issues/health/science/toxics/chemicals-in-your-cosmetics---siloxanes/
- Pierce, Jeffrey L. "Siloxanes and Landfill Gas Utilization" MSW Magazine. June 2015. http://www.scsengineers.com/wp-content/uploads/2015/05/Pierce-SiloxanesandLFGUtilization-MSW-June-2015.pdf

Images

- Global Emissions by Sector – U.S. EPA – https://www3.epa.gov/climatechange/ghgemissions/global.html
- Bolivian Natural Gas Production & Consumption – U.S. EIA – http://www.marcon.com/print_index.cfm?SectionGroupsID=51&PageID=366
- Global Methane Emissions – GlobalMethane.org – http://www.globalmethane.org/documents/analysis_fs_en.pdf
- Bolivian Electricity Generation – IRENA – http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Latin_America_Policies_2015_Country_Bolivia.pdf
- Bolivian Energy Consumption – U.S. EIA – http://www.marcon.com/print_index.cfm?SectionGroupsID=51&PageID=366
- AD Facilities in Germany – "The Case for Crop Feedstocks in Anaerobic Digestion"
- Waste Composition – El Alto, Bolivia – KTH – http://carbonn.org/uploads/tx_carbonndata/D21_Strategies%20to%20implement%20biogas%20in%20Bolivia%20Summary%20for%20Policy%20Makers%20July%202014.pdf
- Waste Composition – La Paz, Bolivia – KTH – http://carbonn.org/uploads/tx_carbonndata/D21_Strategies%20to%20implement%20biogas%20in%20Bolivia%20Summary%20for%20Policy%20Makers%20July%202014.pdf
- Total Biogas Upgrade Cost in the United States – UC Davis – http://biomass.ucdavis.edu/files/2015/10/Biogas-Cleanup-Report_FinalDraftv3_12Nov2014-2.pdf
- Biogas Yields – The Case for Crop Feedstocks in Anaerobic Digestion
- Bolivian Natural Gas Pipelines – YPFB – http://www.marcon.com/print_index.cfm?SectionGroupsID=51&PageID=366

- RNG Pipeline Costs – NPC – http://www.npc.org/ftf_topic_papers/22-rng.pdf
- Bolivian Electrical Infrastructure – http://www.marcon.com/print_index.cfm?SectionGroupsID=51&PageID=366

Scholastic

Assignments (Available upon request)

- Kenney, Tanner. "The Luanda 2025 Proposal" Final assignment for NYU's Center for Global Affairs course *Clean Technology: Developments, Trends, Opportunities*. 12.10.14
- Kenney, Tanner. "The La Paz Personal Pollution Proposal" Final assignment for NYU's Center for Global Affairs course *Bolivia: A Case Study in Sustainable Development*. 2.20.15
- Kenney, Tanner. "A Fork in Bolivia's Energy Path" Final assignment for NYU's Center for Global Affairs course *Introduction to Energy Policy*. 3.11.15
- Kenney, Tanner. "Sustainable Energy for All Time" Final assignment for NYU's Center for Global Affairs course *Energy & the Environment*. 5.12.15
- Kenney, Tanner. "Leave Them on the Ground" Op-Ed, final assignment for NYU's Center for Global Affairs course *Energy, Environment, & Resource Security*. 11.2.15

Class & Field Notes

- Energy & the Environment – 2.3.15; 2.10.15; 2.17.15; 2.24.15; 3.3.15; 3.10.15; 3.24.15; 3.31.15; 4.7.15; 4.14.15; 4.21.15; 4.28.15; 5.5.15; 5.12.15
- Bolivia Global Field Intensive – 11.14.14; 11.15.14; 11.16.14; 1.6.15; 1.7.15; 1.8.15; 1.9.15; 1.10.15; 1.11.15; 1.12.15; 1.13.15; 1.14.15; 1.15.15; 1.16.15; 1.17.15; 1.8.15
- Berlin Global Field Intensive – 3.23.15; 3.30.15; 4.6.15; 4.13.15; 4.20.15; 4.27.15; 5.3.15; 5.8.15; 5.9.15; 5.11.15; 5.25.15; 5.26.15; 5.27.15; 5.28.15; 5.29.15