Diversity of Energy Resources Utilized in Brazil

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Author Note

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DIVERSITY OF ENERGY RESOURCES UTILIZED IN BRAZIL: ARE THEY SUSTAINABLE?

Abstract

Over the years Brazil has generated power from numerous energy sources, from sugar cane, ethanol, hydroelectric, and more recently, petroleum and natural gas. As Brazil's economy grows and the country continues to develop their energy profile is likely to change and adapt with availability and economic practicality of natural resources. There is much debate on whether the recently discovered oil reserves in Brazil responsible shifts away from biofuels will be a reliable source of energy and wealth for the growing country. This research will examine the factors that have led Brazil to its recent increased consumption of fossil fuels, and consider whether this trend is likely to continue, or likely that Brazil will utilize other natural resources more heavily.

Background

Brazil has been one of the top global producers of sugar and sugarcane for centuries, but the real spike in growth of sugar cane production began in the 70's after the global oil shock of 1973. In 1975 the Brazilian government initiated a program to incentivize the production of sugar can so that the country could reduce its dependence on fossil fuels, especially from foreign sources. As a result, production quickly rose from 580 million liters in 1975 to 3.676 billion liters in 1979. The production of sugar cane continued to grow year after year as the oil crisis created more motivation for Brazil to shy away from foreign oil. In '85 the price of oil dropped, as a result so did the production of ethanol. Ethanol quickly went from a reliable domestic resource of Brazil to a scarce one. This downward trend in production lasted until about '89 when analysts recommended continued support for production of sugar cane for ethanol. Shortly after in '91 the government deregulated sugarcane and ethanol production. From this point until 2008, production boomed (Goldenberg, 2014).

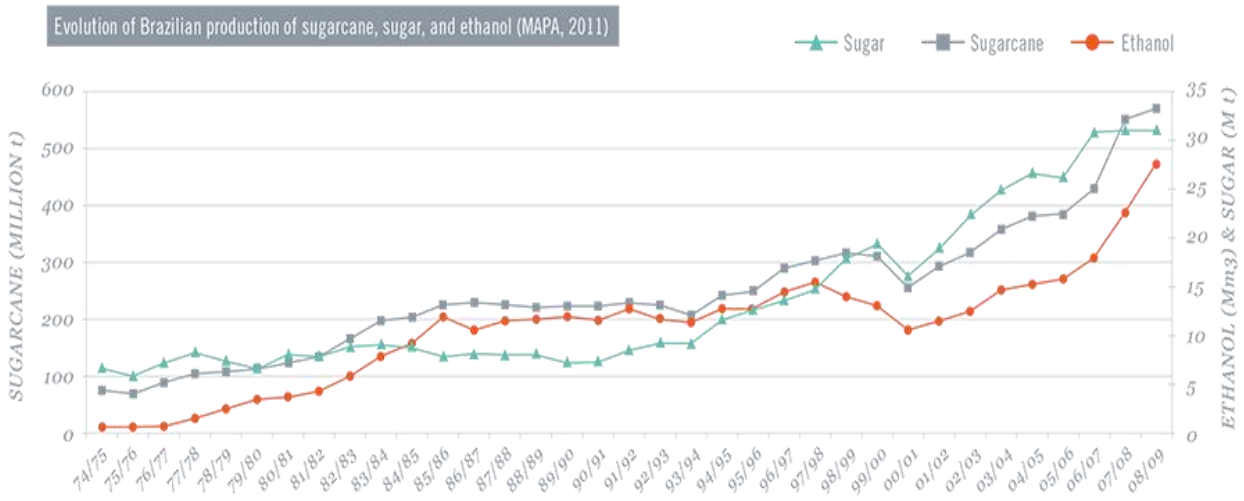

Figure 1. This chart represents sugar cane, sugar, and ethanol production 1974-2009

In 2008 the Brazilian government began taxing gasoline less and less, artificially maintaining a lower price until 2012 when the amount taxed became zero. This has limited the production of sugar cane and ethanol once more (Goldenberg, 2014). Growth in production of ethanol has been limited since then.

Hydroelectric power was generated in Brazil as far back as the ‘40s, but considerable generation didn’t occur until the ‘70s and ‘80s. Hydroelectric power has contributed a large percentage of Brazil’s energy ever since. In 2008 Brazil ranked 2nd in the world for meeting domestic energy demand with hydroelectric generation of electricity covering 79.8% of demand domestic energy demand.

Current Energy Profile

Brazil is currently the second largest producer of ethanol in the world, with the peak in production so far being 30 million cubic meters in 2010 (Moreira, Pacca, Parente, 2014). A large percentage of cars on the road today in Brazil are flex fuel vehicles, meaning they can run on any mix of ethanol and gasoline. The average mix of fuel in the country comprises of 18-25% ethanol (Moreira, Pacca, Parente, 2014). Brazil also ranks second worldwide in production of hydroelectric energy. 65% of Brazil’s total electricity generation comes from hydroelectric power (Dale, et al, 2013). And as of 2006 Brazil is self-sufficient in oil production. The latest report from the International Energy Agency (IEA) states that Brazil meets primary energy demand with 38.4% petroleum, 15% hydroelectric, 13.7% wood fuels, 13.1 sugarcane byproducts such as bagasse, 9.1% gas, 6.4% coal, 2.9 other renewables, and 1.4% nuclear power (IEA, 2006). Figure 2 shows the various sources of electricity utilized by Brazil. Hydroelectricity

is clearly represented as the largest source, with natural gas and biofuels/waste (ethanol) following as second and third largest contributors.

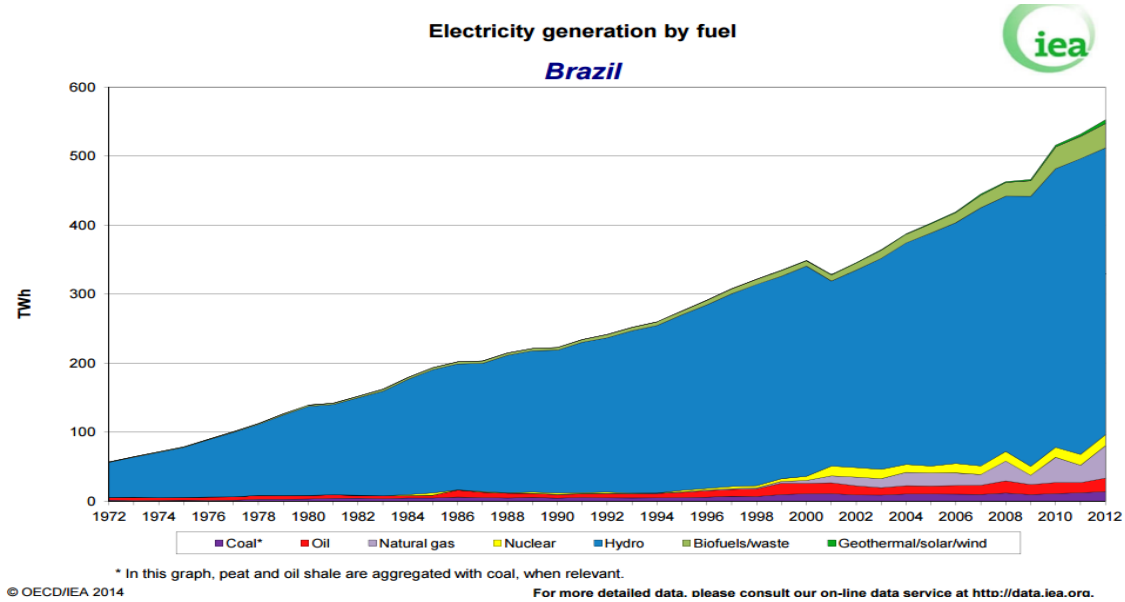

Figure 2: this chart illustrates the percentage of total electric generation from each source.

Growth of a Nation: Population and Consumption

Figure 3: Trend in Brazil's GDP 1990-2015

Over the last 25 years Brazil's economy has seen significant growth. GDP in 1990 was 425.6 billion USD, and in 2013 reached an all-time high of 2476.69 billion USD. From 1971 to 2008 the population of Brazil doubled, and electricity consumption per capita increased five-fold. While Brazil is able to boast entirely self-sufficient domestic oil production, and 65% electricity production from hydroelectric sources, the country may need to transition to a more sufficient energy profile in the coming decades in order to account for continued demand increases. As population size and electricity consumption continue to rise together in the future, the increase in energy demand will be compounded.

In the last decade Brazil has emerged as one of the global leaders in oil production. This recent economic boom in Brazil's oil sector can be attributed to the discovery of large oil fields offshore called pre-salt oil. Advancement in oil drilling technology has allowed for greater exploration deeper underground which lead to exploration of areas such as the pre-salts. The economic success surrounding the new discoveries has geared Brazil away from its focus on sugarcane production for ethanol and has redirected its focus on the oil industry. Sugarcane has long been a focus of the Brazilian economy and in recent decades so too has the development and success of a market for ethanol. With the focus in development taken away from sugarcane and ethanol production Brazil is reinforcing its future dependence on fossil fuels, just what it aimed to avoid in the 70's. Considering current and projected trends in growth and consumption this switch towards fossil fuels is one to be questioned if Brazil hopes to maintain its energy independence.

Energy for the Future: Which Energy Sources are most Viable?

Brazil is currently ranked as the 13th largest producer of oil in the world. As of January 2014 Brazil was stated to have a total of 13.2 billion barrels of oil in its reserves, over 94% of which are located off shore in pre-salt oil fields. *Figure 4* represents the comparison of Brazil's oil production vs. consumption for the last ten years. While both have been on the rise, consumption has overtaken the rate of production as of 2010. National oil production peaked at around 2.7 million barrels per day in 2013 while consumption reached 3.0 million barrels per day and continues to rise. Brazil has estimated 4.0 million barrels per day of oil production in 2020 which should meet the projected demand once more; however this projection is a lesser figure than previously estimated (EIA, 2014). While Brazil has recently made a huge presents on the world economic stage with these oil field discoveries, the future balance between supply and demand of oil in Brazil is questionable.

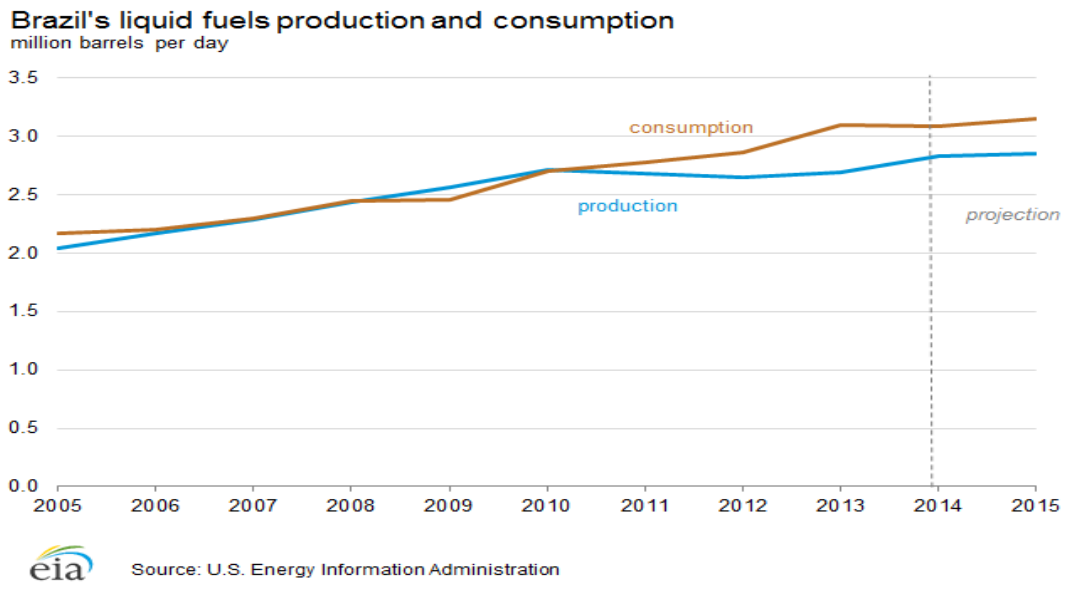

Figure 4: Consumption vs. Production of Oil in Brazil

In a study conducted in 2012, researchers Jose R. Moreira, Sergio A. Pacca, and Virginia Parente analyzed capacity for energy from biofuels derived from sugarcane, as well as from petroleum and natural gas based on recently discovered pre-salt reserves in their ability to meet Brazil's energy demands as they continue to grow through the year 2070. The study conducted analysis of pure energy capacity of each resource and calculated a cost benefit analysis for each resource, including the impact of CO2 emissions. The research found that based on current oil reserves and production capacity Brazil has the ability to more than meet demand until around 2041-2051 at which point production will drop off dramatically until reserves are depleted by around 2070.

In comparison, the results for the energy potential of ethanol production found that there were two likely scenarios, one of high production and one of low production. By 2070 the projected production for the low scenario is 256 million boe[i]. This number represents expected production at the current rates with no further changes implemented. The higher projected figure for ethanol production represents the combination of current ethanol from sugarcane production plus the added energy generated from electricity through burning of sugarcane byproducts and waste. The higher projected estimation of ethanol output is 764 million boe of ethanol. However, neither scenario can be expected to meet the projected demand for oil consumption by the year

2070. *Figure 5* below shows these projected scenarios.

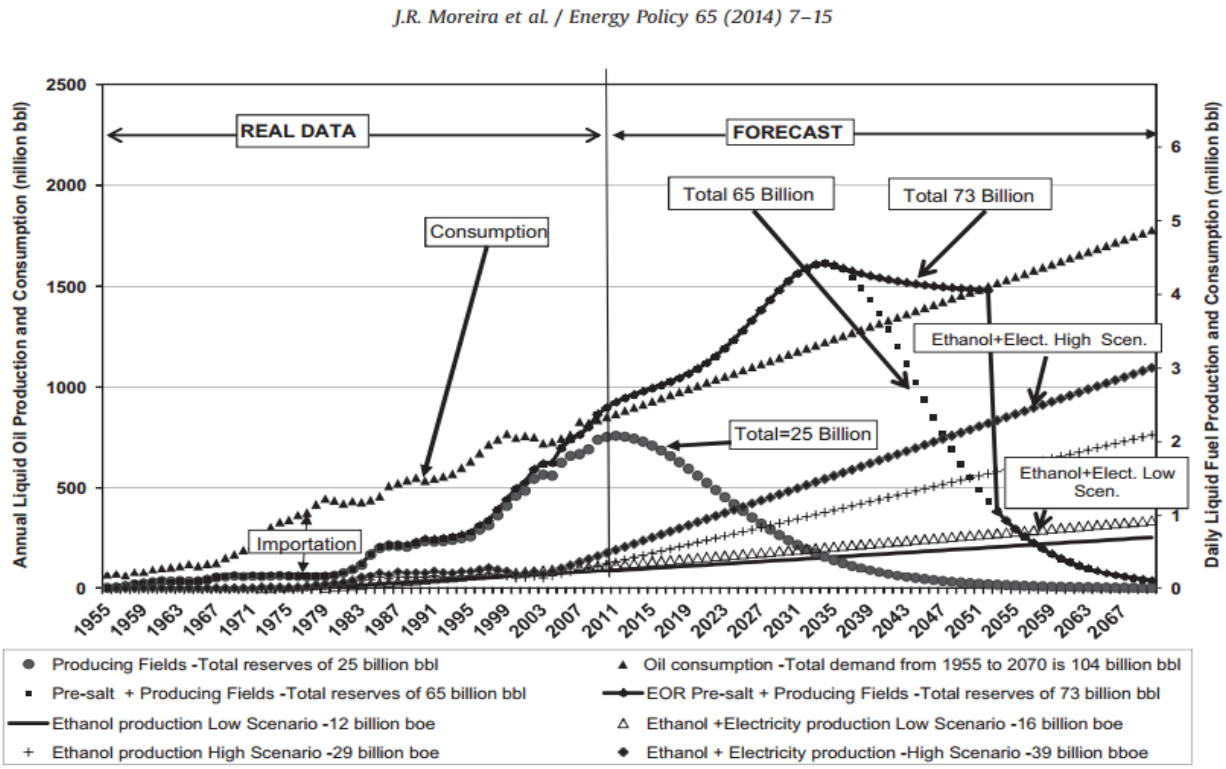

Figure 5: recorded and predicted production levels of oil vs. ethanol

While current oil reserves will generate greater output of energy resources over the next few decades for Brazil, in the long term it might not be the most economically profitable energy source. The same study, conducted by Jose R. Moreira, Sergio A. Pacca, and Virginia Parente, also analyzed the return on investment (ROI) for oil and ethanol. The results concluded that the vast pre-salt oil fields from which Brazil currently extracts more than 90% of its oil from have a significantly lower ROI than pre-existing oil fields. The overhead investment for extracting from pre-salt oil deposits is higher than average. ROI for pre-salt oil is .56 compared to 1.23 for existing fields (Moreira et all, 2014).

The study further analyzes ROI of oil by internalizing the cost of CO2 emissions. This data only further lowers the ROI for oil production in pre-salt and established fields. In

comparison this gives one point to the viability of ethanol production. Since ethanol emits far less carbon when burned and requires no emissions of carbon in production it is a much more economical choice for the future compared to oil and natural gas which will only generate greater costs the longer they are utilized.

Prediction for Future Energy Production

Brazil has elevated its global status greatly since the 1960s, and the recent discovery of pre-salt oil fields has only increased their economic standing. Population size is on increasing exponentially and so too is the demand for oil and electricity. Brazil currently ranks as a major oil producer of the world, the second largest producer of ethanol, and the second greatest producer of hydroelectricity. Pre-salt oil fields are estimated to provide substantial levels of production for the next 30 to 40 years. For this reason Brazil is very unlikely to step away from this valuable resource any time soon. But, as the country becomes more affluent, the growth in energy demand is most likely to be the most focused on electricity, due to rapid growth in the electronics market. This will create greater demand for biofuel sources like ethanol that can meet significant levels of demand with very little economic impact and can be sustained long term unlike oil deposits which will eventually become depleted or insufficient. But as described previously ethanol production lacks the capacity to fully meet growing demand in Brazil in the coming decades. Brazil will be in need of additional sources for energy production, especially electricity. Their vast production of hydroelectric power will continue to meet a large portion of demand. The historic success of this energy source will most likely spur further development to meet growing energy demands.

Conclusion

To conclude, Brazil has a unique and somewhat diverse energy profile. Historic development of hydroelectric power generating sources as well as ethanol and other biofuels from sugarcane have proved to be highly successful. These energy sources have enabled Brazil to vastly grow its economy while maintaining a significantly lower environmental impact from GHG emissions per capita. The discovery of pre-salt oil reserves has provided Brazil with an additional competitive edge for the time being. But the country is at a crucial point in its history. It is at a crossroads between continuing development and support of oil and natural gas production and using it as a framework for the future, or taking this economic opportunity to recognize the advantage of greater investment and support of renewable energy sources such as ethanol from sugarcane and hydroelectricity, and even wind and solar which they have yet to utilize. In the past Brazil sought independence from fossil fuels and foreign oil and found great success. The current oil resources in Brazil are significant, but research has demonstrated that production is more costly than previously stated and is occurring at a lesser rate as well. These resources will not sustain the country's economy for long into the future, but the alternatives for energy production may be viable and even better long term.

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[i] Boe-barrels of oil equivalent