Powering the Pearl: A Study of Cuba's Energy Autonomy

Elizabeth Worsham, B.S. Mechanical Engineering[1], Genesis Vargas Esposito, B.S. Computational Mathematics[2]
[1]Embry-Riddle Aeronautical University, USA, elizabethkworsham@gmail.com
[2]Embry-Riddle Aeronautical University, USA, vargas.genesis@hotmail.com*

Abstract*– Cuba's national pride comes from their projected autonomy as a communist country, although they have been dependent on other countries to supply them with resources since the revolution. However, Cuba has a high capacity for various forms of renewable energy. This study analyzes the impacts of Cuba's decline in petroleum use and the rise of renewable energy. There is a lack of primary research on Cuba's energy infrastructure because of government censorship and availability of reliable data, so this study utilizes accounts from Cuban citizens as well as first-hand observations of the country. Research was conducted through interviews, observations, and written accounts of life in Cuba. The decline of Cuba's use of petroleum has led to an emphasis on sustainability, affecting people's lifestyles and the economy. The inability to produce enough electricity has created an inequality between those who are involved in tourist industries and those who are not. However, the dawn of renewable energy is helping to close that gap while protecting Cuba's energy independence and preventing another Special Period.

I. Background

History shows that Cuba has never been truly autonomous since its beginnings in 1492, when Christopher Columbus mistook the island to be part of Asia on his search for another path to India. After 376 years of Spanish colonial rule, during a time of upheaval and outside war, revolutionary Carlos Manuel de Céspedes, a lawyer and landowner, freed his slaves on the 10th of October, 1868 [30]. He declared the independence of Cuba from Spain, and became known as the Father of the Country. This declaration sparked the Ten Years' War, which was the first, and failed, war of Cuban independence.

The second war of Cuban Independence led to Revolutionary José Martí to form a group of rebels and other revolutionaries to seize the island. Successful battles were won in key cities, but the destruction of the USS Maine sent out of fear for the Americans in Cuba [30]. U.S. President William McKinley asked Congress to send forces to end the Cuban civil war, and Cuban independence was founded. Unfortunately, this independence was only from Spain. As the U.S. government assisted Cuba in their fight for independence from Spain, they fostered political changes. The United States selected Cuban presidents to serve as figureheads to push toward policies that were favorable to the American agenda, and corruption grew steadily in the government. This continued as Fulgencio Batista came to power in the 1930s. Batista was working in cohort with the U.S., ensuring that the economic ties between Cuba and America were always strong. With a narrow outlook on this, taxes rose for the Cuban people, the unemployment rate grew, and the middle class quickly grew unhappy.

Digital Object Identifier: (to be inserted by LACCEI).
ISSN, ISBN: (to be inserted by LACCEI).

This began the third revolutionary period in Cuba, when a young lawyer named Fidel Castro and his brother Raúl challenged the legitimacy of Batista's presidency once more. In 1953, a failed attack on an important military compound led to the Castros being exiled in Mexico [30]. Years later, the Castros fought back with other revolutionaries, such as Che Guevara and Camilo Cienfuegos, to bring down the Batista administration. In January 1959, Batista fled Cuba as the Cuban military became demoralized against the rebel attacks, and Fidel Castro took over [30]. From there, Cuba quickly placed communistic label and rejected the "imperialism" of the United States. Since the Castro regime refused to make use of its neighbor's economy and imports, they sought refuge and assistance with their political ally: The Soviet Union.

Cuba's main domestic production came from the sugar exports, and since their alignment with Soviet Union, the Soviet oil-for-sugar arrangement came to light. However, in early 1990, Russia "registered the steepest decline in Soviet crude oil production since the end of World War II [29]." In the rest of the 1990's, after the collapse of the Soviet Union, Cuba entered its "Special Period" in which it faced energy shortages that caused oil consumption to drop by 20 percent from 1989 to 1992. "Trade Ministry spokesman Igor Makurin…stat[ed] that beginning in 2000 only Russia's private trading companies will be involved [29]." This further dramatically decreased Cuba's oil imports. Fortunately for Cuba, in 1999, Hugo Chavez came to be a prominent figure in Venezuela, and saw potential for trade with the island nation, leading to a trade agreement between Cuba and Venezuela that would last for most of the 2000's [23].

Energy continued to be a challenge for Cuba: In 2004, hurricanes left a million people without electricity for 10 days, and in 2005, the electricity system was functioning at only 50 percent of its installed capacity, leaving its citizens in blackouts that lasted seven to twelve hours on a daily basis [9]. What followed was the fourth Cuban revolution: the Cuban Energy

* This research was supported by an Ignite Travel Grant from the Office of Undergraduate Research at Embry-Riddle Aeronautical University Daytona Beach.

Revolution, which focused on replacing inefficient infrastructure, encouraging energy efficiency, expanding electricity availability, and pursuing renewable energy generation. These changes appear to have dramatically affected Cuba's energy strategy. Cuba has a high capacity for various renewable energy sources, including wind, biomass, solar, and hydropower, and as of 2014, Cuban energy experts estimate that renewable sources make up about 7-8 percent of total electricity generation [9]. Energy production from oil decreased from over 14 billion kWh in 2009 to 7.7 billion in 2011 [31].

However, Cuba now faces another grim energy prospect that may cause a crisis like the "Special Period." For decades, Venezuela provided 50 percent of Cuba's oil, but due to economic and political crises there, those oil imports were stalled in July 2016 [8]. Since then, neighborhoods in Cuba have been facing widespread blackouts, similar to those of the 1990's. It seems the efforts of the Energy Revolution are unable to keep up with the sudden degradation of a reliable oil trade. Cuba must make changes quickly to ensure suitable and equal access to electricity for its citizens.

II. Methodology

It is important in any research to collect data without influencing the views of participants, and to collect multiple types of data in order to validate research findings. As this was a qualitative study, it was especially important because the results are open to interpretation and often involve direct interaction with participants. A researcher should be "self-reflective about his or her role in the research, how he or she is interpreting the findings, and his or her personal and political history that shapes his own interpretations [33]."

It is crucial to verify the accuracy of the information through processes such as triangulation. "Triangulation is the process of corroborating evidence from different individuals (e.g. interviewing both a principal and a student), types of data (e.g. observational field notes and interviews), or methods of data collection (e.g. documents and interviews) [33]." Data was collected through multiple sources including observing the environment and behaviours of people, as well as observing any added energy structures like local solar panels or wind power. The three methods of data collection used in this study are interviews, artefacts, and literature review.

Interviews

Interview participants consisted of Cubans in various vocations and backgrounds. Participants were chosen as an opportunity to interview was presented. This gave a detailed understanding of how electricity affects Cubans of different walks of life and how certain industries are affected.

Questions included:

- How much do you rely on electricity in your daily business?
- What are the most common electronic items you use?
- Do you know how your electricity is generated (i.e. oil, solar, wind)? If so, how?
- Do you ever experience periods without electricity? If so, how do you prepare for or deal with the situation?
- Has your use of electricity changed since the Revolution? If so, how?

Throughout the interview process, there were some language barriers in translating from English to Spanish and vice versa, however, it was important to interview non-English speakers despite this barrier. By only interviewing English speakers, there is a potential for bias because those citizens may be in different social or economic levels than those who do not.

Interviews conducted to non-English speakers were translated to English by fluent Spanish speaker Vargas. In addition to language barriers, some questions may be sensitive due to the strict nature of Cuba's government. Conversations and questions were adjusted to make sure the participant felt comfortable with the information they were sharing throughout the interview. In addition, minimal information about the participants are included in this report to protect their identities while maintaining academic integrity.

Artefacts

Spending several days in Cuba offered the unique opportunity to observe the behaviours of its citizens and its landscape. Observations of visible energy infrastructure was recorded in notes and photographs, as well as applicable electronic devices or energy use habits. Other artefacts include news articles and blogs, especially the Havana Times, which offers first-hand accounts of blackouts and other events in Cuba.

Literature Review

Information gathered within Cuba is combined with previous research to verify and dispute observations. By gathering information from other sources, the possibility for confirmation and other biases will be decreased, as well as allowing for quantitative data to be incorporated into the study.

III. Tourism and the Economy

Much of Cuba's modern economy relies on tourism, and the government employs certain protections to ensure that tourists are comfortable and see only the best of Cuba through the duration of their stay. Nearly all tourists, hailing mainly from Europe, Asia, and Canada, are given a guide and a strict itinerary of Cuba's historic and popular sites. Guests are given

little free time to explore the city on their own. Hotels are equipped with air conditioning, water heaters, and buffets with meats, cheeses, and fresh fruits. These luxuries are not available to the average Cuban citizen. The average government salary is about 500 CUP (Cuban Peso) per month, or 20 CUC, (Cuban Convertible Peso) [12]. Cuban convertible pesos are currency that are only used for tourism and luxury purchases. For perspective, a meal in a tourist restaurant costs about 15 CUC, far above what could be afforded by the average Cuban family. This dual-currency system was developed to allow the American dollar back into the island, where before 1993, it was illegal to possess American currency [11]. This change came as a result of Cuba needing hard currency after the collapse of the Soviet Union. Once the American dollar became legal, the amount of tourists coming to the embargoed island rose quickly.

Because tourism is so important to the economy, Cubans are seeking jobs in tourism because there is more money and benefits associated with the industry. The majority of those who graduate with any degree end up either employed with the military, healthcare, or the tourism sectors as they are most in-demand and provide greater income than other careers. According to an employee of the national power grid, the tourism grid receives more electricity than what the native Cubans receive [10]. The separation of tourist and local currency also means that money of more value is circulating, where tips and trades lead to hefty bonuses on top of government salaries. Even those who went to school for a different career may pursue careers in tourism because of the drastic difference in income. A hotel waitress could make up to 15 CUC per night in tips, while a doctor is paid 30 CUC per month on average [33]. In 2017, it is estimated that travel and tourism will have contributed to 117.5 thousand jobs to the Cuban economy [26]. These jobs are critical in ensuring that Cuba brings more tourists to spend money, and bring in profit for the island.

Involvement in the tourism industry can also lead to a better quality of life, not only because of higher pay, but because of government provided amenities and services that cater to the comfort of tourists. A new initiative from the government allows citizens to convert their homes into hostels for travelers. A hostel in Viñales was equipped with air conditioning in every room, hot water, a full kitchen, refrigeration, and laundry services. The facilities were clean, and the house was well decorated. The hostel initiative turned the home into a business, with employees within and outside the family cooking and cleaning for the travelers as needed. Passport information about the visitors are recorded and reported to the government as with a regular hotel.

Figure 1: At a hostel in Viñales, the owners use electrical appliances to prepare meals.

The government subsidizes these families by providing free electricity and other services [27], and it can be inferred that the facilities are inspected regularly and maintained for travelers. In an interview with the homeowner, he explained that the town where they live was not at all developed before the revolution. Everyone farmed, there was no access to electricity, no large edifices, and the only transportation outside the town was the occasional train. Now, they are living with the amenities of a middle-class family in America without the bills or utility costs. Exactly stated by the Hostel owner "Todo fue Castro, todo fue Castro." It was all Castro, it was all Castro, confirming the importance of the new government and equal access to resources for rural areas [11]. Cuba's economic system is slowly shifting away from communism. As a result of this, the economy is beginning to see more revenue, primarily from tourists. This rise in tourists, as could be observed in Viñales, is correlated with an explosive rise of new construction for tourist accommodations, such as hostels, bed and breakfasts, etc.

In addition to the hostel initiative, citizens are using the draw of tourism to start private businesses and work independently. One popular initiative allows owners of vintage cars to obtain a license to work as an independent taxi service [10]. This service is both increasing quality of life while maintaining Cuban culture. These businesses are helping Cubans to increase their income, but also pull more electricity from the grid. Per the Havana Times:

> "The economic reforms undertaken by Cuban President Raul Castro have resulted in a 30 percent increase in energy consumption over the past five years. Much of the increase in energy consumption is due to the increase in small businesses such as restaurants and bars, and the growth of household consumption by purchasing new appliances." [7]

IV. Lifestyle

One of the major benefits from the communist government in Cuba is that electricity is guaranteed to all, regardless of

location. Cuba ranks second only to Denmark in distributed energy generation [9]. For those who live too far out for the infrastructure to reach, they are given a solar panel and a hand crank to provide electricity [11]. In general, the electricity consumption in Cuba is very low; Cuba consumes about 1.5 million kWh per capita annually, compared to the United states, consuming almost 13 million kWh per capita annually [3]. In most households, electricity is only used on basic necessities, such as cooking, small appliances, television, fans and lighting, as observed. Washing machines and dryers are not common in the city or country, making full clotheslines a common sight all over Cuba. In hotels, hospitals and schools, solar water heaters are often installed [9].

Cuba has instituted several initiatives to encourage domestic energy savings from its citizens. In 2009, household electricity use accounted for 36 percent of the total compared to 25 percent industrial use. Most notably, tariffs were implemented to promote electricity saving. People consuming less than 100 kilowatt-hours (kWh) per month pay a heavily subsidized rate of 38 US cents/kWh. For every 50 kWh of additional electricity use, the tariff progressively increases [99]. In most households, all appliances are electric powered rather than gas. The government also supplies households with newer, more energy efficient, small appliances. For decades, households were using outdated appliances that continue to lose efficiency as they age. In the last few years, these appliances have been replaced with newer versions. Some of these appliances are provided by the government, but larger appliances, like refrigerators, are available at a subsidized cost. Although expensive, the government markets the energy-saving benefits of purchasing a newer appliance as an act of patriotism [17]. Perhaps cleaner, more efficient energy generation would help the government subsidize the costs of these expensive "luxury" items even more.

Figure 2: In both the city and the country, clothes are hung out to dry on lines and railings.

The energy saving measure that has the most significant impact on lifestyle are scheduled and unscheduled blackouts within the commercial and residential sectors. Unscheduled blackouts have been documented in blogs and online newspapers, such as the Havana Times. After a widespread blackout in September 2016 due to an error at the power plant, photos of the plant manager's luxurious house emerged, prompting the Havana Times to write:

> "Although the breakdown on September 9 wasn't directly connected to the squandering of resources at the manager's house, we know that these privileged evade the power saving measures that the people have had to make on many occasion" [6].

This showed that these energy restrictions and blackouts do affect the daily life of the people, as it is noted that most Cubans make sacrifices to deal with the problems faced by the national grid. There is also resentment of the unfair, classist, distribution of power, contradicting the ideals of a communist society. Another blogger recounted a day that she came back to her apartment with an unexplained blackout that disrupted her normal activities: "'Tis a puzzlement as the King once said and not in an intriguing, brain teaser kind of way, but rather in that 'how am I going to cook dinner and keep cool?' kind of way [5]." Blackouts at businesses are often scheduled. At a Cuban Red Cross location, there are blackouts Mondays, Wednesdays, and Fridays, from 8 to 11 a.m., making work difficult during those times.

Transportation is also affected by the lack of available oil. It is very expensive to maintain and operate a car, and even more expensive to buy [14]. Gasoline is the price of approximately 1 CUC (23 CUP), for 1 liter. There are 21 passenger cars on the road for every 1,000 Cubans [15]. The prohibitive cost of personal transportation leads people to resort to other methods. In the city, daily commuters pack onto public buses at the density of a New York subway. In the country, many people use horses and oxen for transportation and to pull farming equipment, and people stand in the roadways hoping someone will stop to take them to work and other daily destinations.

Figure 3: In the country, many Cubans rely on horses and oxen for transportation.

V. Sustainability

In the previous section, it was discussed how entering the tourism business elevated the lifestyle of a family in the country. In addition to the money brought in from tourism, the "Energy Revolution" that shifted Cuba from a centralized to distributed system allowed Cubans outside major cities to access electricity. According to Käkönen, Kaisti and Luukkanen:

> "Currently, Cuba has a generating capacity of 2497 megawatts (MW) based on distributed generation –1280 MW corresponds to diesel generators and the rest are fuel oil motors (540 MW), CHP (529 MW) and renewable technologies (69 MW) (ibid.). This means that 42 percent of the generation capacity is in distributed systems: a very significant shift away from a centralized power system. The distributed units are generally of a size of 3 to 10 MW". [9]

Cuba has high potential for solar, wind, and biomass renewable energies [1], and already makes use of it by providing renewable energy to citizens in areas where they are most efficient [11]. For example, the "oriental," or coastal regions, are often powered by wind farms. This strategic use of renewable energy aids in the development of the distributed power system, increases access that citizens get to electricity, and therefore increases quality of life. In 2014, "7-8 percent of [Cuba's] total electricity production" was accounted as renewable energy [9]. This was also corroborated by Jorge Piñon, the Director of the Latin America and Caribbean Energy Program at the University of Texas-Austin: "The Island is totally dependent on energy from fossil fuels; currently only four percent of its production originates from renewable energy."

The two biggest aspects holding the country back from a complete and full Energy Revolution are their current dependence on petroleum, and their ability to trade and purchase on the market. In order to purchase resources for solar panels, the Cuban government needs tradable currency such as Euros, American dollars, etc. This increase in tourism provides them with proper tradable currency to make the right actions to purchase materials from outside of Cuba. With little advances in technology in the country, the cars, machinery, and electricity are dependent on petroleum and natural gas. In 2013, "oil accounted for about 85 percent of the electricity generated in Cuba [18]. In 2013, energy use was 1031 kg of oil per capita [2].

The majority of this oil has been imported from Venezuela, a petroleum-rich country in South America. In trade for medical experts, teachers, and other workers for the public sector, Venezuela provides Cuba with petroleum at an extremely subsidized, due to Former Venezuelan President Hugo Chávez and Fidel Castro signing the *Convenio Integral de Cooperación* in October 2000 [23]. Since then, the amount of oil has fluctuated dramatically over the years, with Venezuela initially proving 53,000 barrels of oil a day (bbl/d) in 2000 [23], to 90,000 bbl/d in 2005, up to 100,000 bbl/d in 2011. With political and economic unrest in Venezuela, Venezuela's state oil company, *Petroleos de Venezuela, S.A.*, had cut back the amount in 2014 to 55,000 bbl/d. In 2016, Cuba began to receive on average 53,500 bbl/d, a decline of 40 percent from 2015 levels [18].

To combat this extreme decline in Venezuelan oil imports, Cuba began to focus on the resources they have on hand: natural gas and oil in the coastal regions. Cuba has resorted to fracking to extract oil along the coastal region with technology they have from the Soviet Union.

Figure 4: Oil fracking machinery is present on the Northern coastal region, between Havana and Matanzas.

This oil production is shared with contracts between Venezuela and Angola to drill off-shore wells in the northwestern coast of Cuba as it is a rich area for oil [18]. Despite the amount of petroleum they find, Cuba only has four crude oil refineries with a combined capacity of 134K bbl/d [18].

In 2006, President Fidel Castro stated, "We are not waiting for fuel to fall from the sky, because we have discovered, fortunately, something much more important: energy conservation, which is like finding a great oil deposit [9]". The use of old oil burning equipment has contributed to the oil shortage by causing less-efficient fuel burning. Cuba's oil production has been cut in half due to Venezuelan oil crisis in 2015 [4] As quoted in the Havana Times, the Economy Minister, Marino Murillo addressed the National Assembly:

> "Murillo tried to reassure the population in the absence of information in the official media on the energy situation. He confirmed the comments of recent days from workers at state enterprises who had been warned of power cuts of 50 percent in their workplaces as an energy-saving measure" [9].

In other words, this explains why renewable sources of energy are imperative for the island nation. Cuba does not have the capacity yet, the domestic supply of petroleum, nor the once strong import of it from Venezuela. While the relationship between petroleum and Cuba's energy use is complex, Cuba has natural gas resources to curb the fluctuation of energy produced by petroleum. "As of January 2016, Cuba has an estimated 2,500 billion cubic feet (bcf) [18]." In Cuba, Canadian company Sheritt International's joint venture with the Cuban government, Energas S.A., cycles through and filters natural gas produced by the country. It "processes raw gas that is then used to generate electricity for sale to the Cuban national electrical grid [19]."

This company has produced 356 MW [19], supplying a major part of Cuba's power generation from its facilities close to Boca de Jaruco, Puerto Escondido, and Varadero. Meanwhile, Cuban authorities seek to generate one quarter of the country's energy use from renewable resources by 2030. However, experts note that it will need new infrastructure and massive foreign investment for this to take place." [7] Recently, with the gradual development of renewable energy and a great push toward a more sustainable power grid, the government has acted on new types of energy as they became available.

Based on the information and data available, Cuba does have the potential to be independent and sustainable with their renewable and even non-renewable resources. The only setbacks are their lack of technology and funds to properly educate, pay their domestic researchers to develop this sustainability, for trading to get raw materials. Cuba is dependent on other countries for off-shore drilling, importing materials to create solar panels, and contracts in creating joint-ventures to develop this energy into electricity to disperse it throughout the nation.

VI. Conclusion

Until now, electrical autonomy has not been possible for Cuba. Relying solely on other countries to import petroleum has led to not just one, but two instances where an unexpected decrease of imports caused Cuba to nearly collapse. This dependence on imported petroleum has made Cuba turn to its own oil reserves in its coastal regions, with outdated technology that needs gasoline or oil to function.

This technology does not burn fuel efficiently, calling for modern technology to be in place to allow a significant decrease on petroleum dependence. In order to protect against another infrastructure collapse and to increase domestic energy production, Cuba is attempting to diversify its energy portfolio in both types of electricity production and foreign partnerships. These partnerships, primarily European and Canadian, assist in the production of energy, either through fracking for petroleum or filtering natural gas.

Meanwhile, the exploitation of the tourist industry as a main source of income is greatly affecting lifestyle by creating an inequality of electrical resources. To ensure that Cuba holds an image of autonomy, and regenerating strength, those in areas associated with tourism have more electricity provided, than those who are in areas not tied with tourism. The decrease in oil imports, and therefore the shortage of electric power has made this inequality more pronounced. Power outages and scheduled blackouts are common occurrences on the island.

The exploitation of solar, wind, and other renewable resources in the areas in which they are best suited can create a more even distribution of resources, reducing the inequality in electricity, boost the economy outside of tourism, and prevent future energy infrastructure collapses in the future.

Acknowledgment

G.V.E. and E.W sincerely thank Dr. Kelly Whealan George of Embry-Riddle Aeronautical University-Worldwide and Mr. Wesley Lewis of Embry-Riddle Aeronautical University-Daytona Beach for their mentorship, sponsorship, and advising on this research paper.

Dr. Whealan George serves as Accreditation, Assessment, and Research Administration is a faculty member in the Social Sciences Economics Program in the Department of Arts and Sciences at ERAU. Dr. Whealan George currently teaches Economics and Statistics courses for ERAU. Dr. Whealan George has over twenty years of teach experience.

Mr. Lewis serves as the Associate Director of Undergraduate Research for the Daytona Beach campus. He joined the Undergraduate Research team in February 2016 and

has been a part of the ERAU community since 2012. Mr. Lewis enjoys working with students to help them achieve their goals through research and active participation within the university. Mr. Lewis earned his Bachelor's of Science in History from Northwest Missouri State University and his Master's of Art in Student Affairs Administration from Michigan State University.

REFERENCES

[1] Ramos, A. L. (2009, September 1). Renewable Energy Sources in Cuba. http://www.havanatimes.org/?p=13250

[2] Cuba: Energy Use per Capita. (n.d.). https://www.factfish.com/statistic-country/cuba/energy use per capita

[3] Electricity Consumption per Capita- For All Countries. (n.d.). https://www.factfish.com/statistic/electricity consumption per capita.

[4] Gámez Torres, N., & Pentón, M. (2016, November 02). Cuban refinery cuts production in half because of drop in Venezuelan oil. http://www.miamiherald.com/news/nation-world/world/americas/cuba/article112094082.html

[5] Posts about blackouts in cuba on Here is Havana. (2012, June 22). https://hereishavana.com/tag/blackouts-in-cuba/

[6] Hernandez, J. .(2012, October 23)., Blackouts and Waste - Havana Times.org http://www.havanatimes.org/?p=80743

[7] Nova, G. (2016, July 07). Does Cuba Face the Specter of Renewed Blackouts? http://www.havanatimes.org/?p=119831

[8] Von Bergen, F. (2016, July 27). Venezuela cuts oil shipments to Cuba forcing Castro to consider veering to U.S. http://www.foxnews.com/world/2016/07/27/venezuela-cuts-oils-shipments-to-cuba-forcing-castros-to-consider-veer-to-us.html

[9] Kakonen, M., Kaisti, H., & Luukkanen, J. (2014). Energy Revolution in Cuba: Pioneering for the Future. https://www.utu.fi/fi/yksikot/ffrc/julkaisut/e-tutu/Documents/eBook_4-2014.pdf

[10] Discussion of Cuban Electricity & Economy [Personal interview]. (2017, March 17) *Translated from Spanish to English by Vargas*

[11] Life as a Cuban Countryside Hostel Owner [Personal interview]. (2017, March 15) *Translated from Spanish to English by Vargas*

[12] Associated Press. (2014, March 21). Cuba hikes salaries for doctors, nurses to as much as $67 a month. http://www.foxnews.com/world/2014/03/21/cuba-hikes-salaries-for-doctors-nurses-to-as-much-as-67-month.html

[13] Gonzalez, E. (2016, May 04). Cuba's Tourism Economy: The Boon and the Dilemma. http://www.as-coa.org/articles/cubas-tourism-economy-boon-and-dilemma

[14] Miroff, N. (2014, January 10). Cuba, Land Of The $250,000 Family Sedan. http://www.npr.org/sections/parallels/2014/01/09/261111796/cuba-land-of-the-250-000-family-sedan

[15] Cuba Transport Stats. (n.d.). http://www.nationmaster.com/country-info/profiles/Cuba/Transport

[16] Overall Car Repair Costs - Cuba, Taxis. (2014, December). https://community.cartalk.com/t/overall-car-repair-costs-cuba-taxis/88525/13

[17] Romero, S. (2007, September 01). In Cuba, a Politically Incorrect Love of the Frigidaire. http://www.nytimes.com/2007/09/02/weekinreview/02romero.html

[18] Cuba. (2016, July). https://www.eia.gov/beta/international/analysis.cfm?iso=CUB

[19] Feinberg, R. E. (2012). The New Cuban Economy, What Roles for Foreign Investment? Brookings.

[20] Castillo, O. G., & Gaspar, N. G. (2002). Tourism Development for the Cuban Economy (English version). https://revista.drclas.harvard.edu/book/tourism-development-cuban-economy-english-version

[21] Kraul, C. (2014, September 11). Exported to Venezuela, miserable Cuban doctors clamor to get into U.S. http://www.latimes.com/world/mexico-americas/la-fg-venezuela-cuba-doctors-20140911-story.html

[22] Lorca-Susino, M. (2008). A Brief Energy Outlook for the XXI Century (Vol. 8, Ser. 15, Publication No. 9557). Coral Gables, FL: Jean Monnet/Robert Schuman.

[23] Corrales, J., Erikson, D., & Falcoff, M. (2005). Cuba, Venezuela, and the Americas: A Changing Landscape (Working paper). Washington, DC: Cuban Research Institute.

[24] Lake, G. (2013, March 09). Ploughing the Sea. https://web.archive.org/web/20160422100021/http://www.theinternationalpoliticalreview.com/ploughing-the-sea/

[25] Yanes, H. (2005). The Cuba-Venezuela Alliance: "Emancipatory Neo-Bolivarismo" or Totalitarian Expansion? (Tech.). Coral Gables: Institute for Cuban & Cuban-American Studies.

[26] Travel & tourism: employment impact in Cuba 2010-2027 | Statistic. (n.d.). 2017, https://www.statista.com/statistics/528466/contribution-travel-tourism-employment-cuba/

[27] Hostals in Cuba: Viñales [Personal interview]. (2017, March 15).

[28] Nanatan, A., Rhymes, E., Vicente-Romero, G., & Khan, A. M. (2014, November 8). Cuba Seeks to Enhance Renewable Energy Capabilities. http://www.telesurtv.net/english/news/Cuba-Seeks-to-Enhance-Renewable-Energy-Capabilities--20141108-0004.html

[29] Alonso, J. F., & Galliano, R. J. (1999). Russia Oil-for-Sugar Barter Deals 1989-1999 [Abstract]. Cuba in Transition, 9, 335-341. http://www.ascecuba.org/c/wp-content/uploads/2014/09/v09-alonso.pdf

[30] Amara, E., Christiansen, K., & Dedio, F. (Directors). (2016, December 8). The Cuba Libre Story [Video file]. https://www.netflix.com/title/80109535

[31] Cuba - Electricity production (kWh). (n.d.). Retrieved May 11, 2017. https://tradingeconomics.com/cuba/electricity-production-kwh-wb-data.html

[32] Greene, D., & Garsd, J. (2014, June 26). Tourism Money Flows Into Cuba, Bringing Economic Hopes And Fears. http://www.npr.org/sections/parallels/2014/06/26/325614454/tourism-money-flows-into-cuba-bringing-economic-hopes-and-fears

[33] Creswell, J. W. (2012). Educational research: planning, conducting, and evaluating quantitative and qualitative research (4th ed.). Upper Saddle River, NJ: Pearson/Merrill Prentice Hall.