

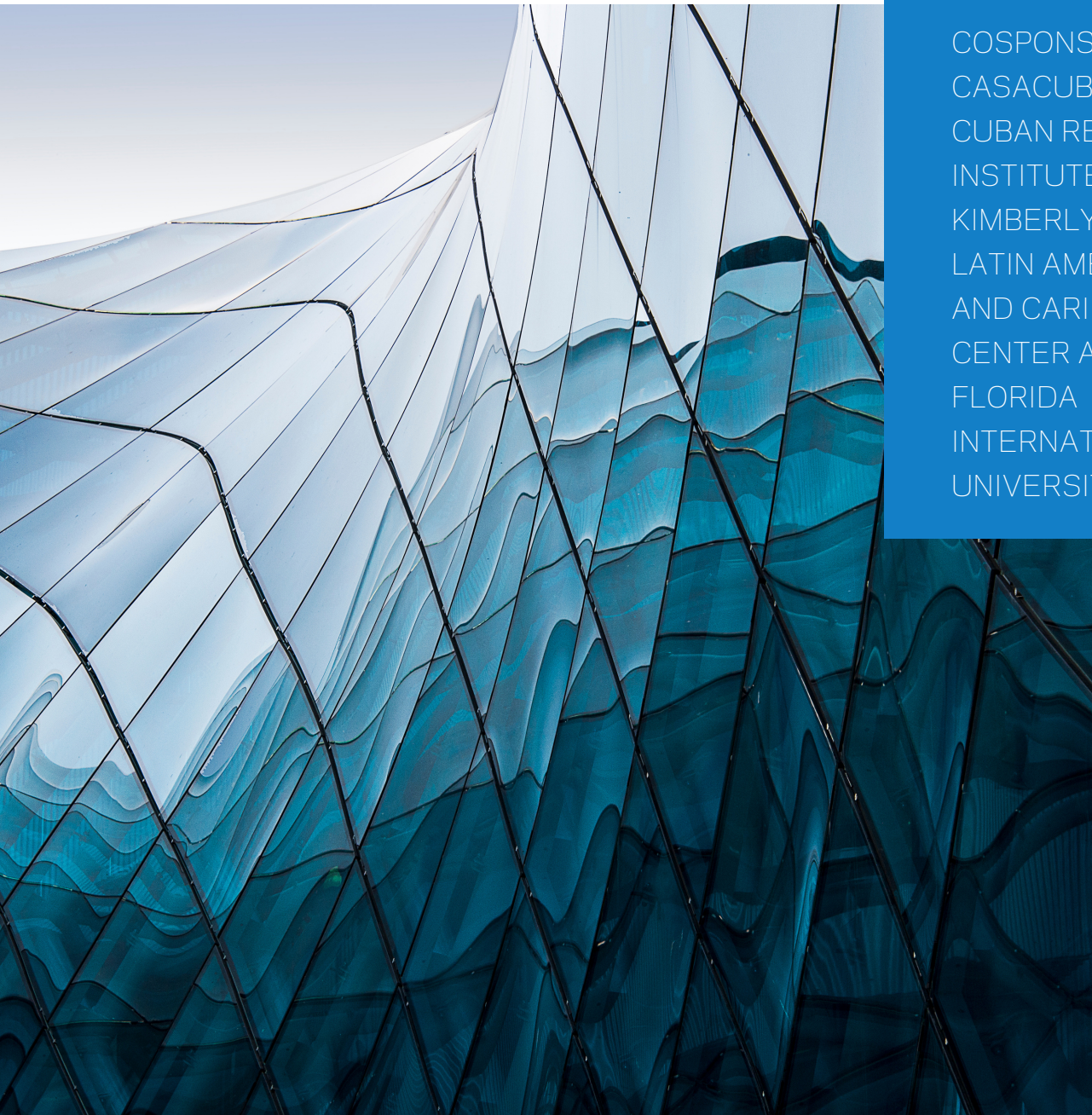
# Cuba's Electric Grid: Challenges and Opportunities

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2023

BRIEFINGS ON CUBA

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## Foreword

CasaCuba, the Cuban Research Institute (CRI), and the Kimberly Green Latin American and Caribbean Center (LACC) at Florida International University (FIU) are proud to continue the publication of *Briefings on Cuba*. The purpose of this series is to provide up-to-date analyses of Cuban politics, economy, culture, and society, by leading Cuba experts, often including public policy recommendations. This is the fifth instance of the series, inaugurated in 2020, with two essays by Carmelo Mesa-Lago and Rafael Rojas; another by Ruth Behar, published in 2022; and the latest one, by Alejandro Portes and Ryan Bagwell, in 2023.

In this briefing, energy industry expert Jorge R. Piñón documents the multiple challenges faced by Cuba's National Electric System (SEN), including an obsolete and collapsing infrastructure, as well as the lack of maintenance capital and the high contaminating effects of its current operation. Piñón predicts the economic and social collapse of Cuba as a result of constant blackouts that intensified during the summer of 2022. He advocates for a decentralized model of planning that incorporates Public-Private Partnerships (PPPs) to rebuild Cuba's electrical system and ensure its transition to a more efficient electric grid that is less reliant on fossil fuels and increasingly based on renewable sources of energy. The main problem for Cuba is how to finance that necessary but costly transition in the immediate future.

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## About the Author



[Jorge R. Piñón](#) is an Energy Fellow at the Energy Institute at the University of Texas at Austin. He began his thirty-two year career in the energy sector when he joined Shell Oil Company's supply and transportation organization. He served as president of Amoco Oil de Mexico and president of Amoco Oil Latin America, based in Mexico City. After the merger between Amoco and BP, he was transferred to Madrid, Spain, to manage BP Europe's western Mediterranean petroleum supply and logistics operations.

Prior to joining the University of Texas at Austin as Director of the Center for International Energy and Environmental Policy's Latin America and Caribbean Energy and Environmental Program, he conducted research and country energy risk assessments as a Visiting Energy Fellow at the University of Miami's Center for Hemispheric Policy, the Brookings Institution, and Florida International University's Latin American and Caribbean Center, where he was a Visiting Scholar affiliated with the Cuban Research Institute. He is the coauthor of *Cuba's Energy Future: Strategic Approaches to Cooperation* (2010).

He holds a degree in Economics and a certificate in Latin American Studies from the University of Florida, from where he received the Center for Latin American Studies 2019 Lifetime Achievement Alumni Award.

Cuba's electric grid, the Servicio Eléctrico Nacional (SEN), faces far-reaching structural challenges that threaten the economic and social development of the Island. The infrastructure of its oil-fired base load thermoelectric and distributed generation has collapsed due to its over forty years of operation and the lack of scheduled and capital maintenance.

In 2022, less than 40% of the sector's total oil thermoelectric based load and distributed generation capacity was operational, which resulted in prolonged blackouts of 8 to 12 hours throughout the country.

To make matters worse, 85% of Cuba's thermoelectric baseload generation is fueled by high sulfur oil, which is highly corrosive with vanadium and sulfur-rich compounds. These compounds produce ash deposits on components such as heat exchangers, boilers, or turbine blades and vanes. This situation causes more damage to the already weakened infrastructure.

It is a vicious maintenance cycle with no end in sight. Cuba cannot move forward toward a reliable, clean, and secure SEN with temporary band-aid solutions, such as the recently leased oil-fired floating power stations, to what are structural problems.

The economic and social costs of the *apagones* (blackouts) are not the only negative impacts from the SEN burning high sulfur liquid petroleum fuels, which are deteriorating the fragile conditions of the electric power generating units, but also the negative impact to public health and the natural environment of Cuba.

Access to efficient and clean energy is needed to ensure a positive impact on people and their environment. Electricity is essential for the well-being of households and commercial activities, as well as the quality of most public services, such as health and education, which depend on it.

There is no short-term solution to Cuba's structural electric power generation challenges. The only solution is the total recapitalization of its base load, distributed generation, and renewable electric power matrix. Regrettably, it would take time and as much as 8 to 10 billion US dollars of investments.

Cuba also needs to meet the challenges of global warming and reduce its carbon footprint by reaching its optimistic 2030 target of 37% share of renewables; but also, by lowering the greenhouse gases and pollutant emissions generated by the burning of highly contaminating high sulfur liquid petroleum fuels.

## Environmental Impact

I acknowledge the Cuban government's challenging aspiration of reaching 37% of its electric generation matrix from renewable sources within the next seven years by the year 2030. Regrettably, there is no detailed strategy for replacing the 63% balance of high sulfur liquid petroleum fueled generation, Cuba's primary source of contaminants and air pollution sources.

Ample peer-reviewed scientific research indicates that breathing sulfur oxide (SO<sub>2</sub>) emissions is linked to various health problems, from lung and cardiovascular disease to childhood asthma. Sulfur dioxide SO<sub>2</sub> emissions also cause environmental problems, such as acid rain affecting soil and water hence damaging biodiversity. These emissions further impact crops, forests, and aquatic species, and contribute to the acidification of oceans.

For the last twenty years, Cuban scientists have raised the alarm in local, regional, and national peer-reviewed scientific articles, demonstrating the negative environmental impact of burning high sulfur liquid petroleum fuels in the industrial, electric generation, and transportation sectors.

*...the cities with the worst levels of air quality are Mariel, Nuevitas, Moa, Havana, Santiago de Cuba, Cienfuegos, and Matanzas...sulfur dioxide (SO<sub>2</sub>) is the pollutant that is emitted the most into the atmosphere in Cuba, followed by nitrogen dioxide (NO<sub>2</sub>) and carbon monoxide (CO), associated with the burning of fossil fuels.*

Dr. Rosemary López Lee, Director, Center for Atmospheric Contamination and Chemistry (CECONT), Cuba, July 2022

## Natural Gas

As Cuba rebuilds its aging, inefficient, and highly polluting base load thermoelectric and distributed generation, Cuba should also consider a fuel switching strategy from high sulfur liquid fossil fuels to cleaner-burning liquified natural gas (LNG).

Even though natural gas is a fossil fuel, it does not emit soot, dust, or fumes. It generates 30% less carbon dioxide (CO<sub>2</sub>) than high sulfur fuel oil, with a twofold reduction in nitrogen oxide (NO<sub>x</sub>) emissions and almost no environmentally-damaging sulfur dioxide (SO<sub>2</sub>) emissions. Natural gas, like any other fossil fuel, produces CO<sub>2</sub>; however, due to the high hydrogen-carbon ratio of its molecules, its emissions are 25% to 30% less than fuel oil.

The low environmental impact properties of natural gas, its energy performance, and its abundant recoverable resources distributed worldwide make it an energy of the future. According to the International Energy Agency (IEA), natural gas use is expected to account for 25% of the world's primary energy portfolio by 2035, and the IEA reaffirms its role in supporting a transition to net zero energy systems.

Sulfur dioxide (SO<sub>2</sub>) is the leading cause of acid rain, which is responsible for the destruction of forests and the acidification of bodies of water. Natural gas has a sulfur content of less than 10ppm (parts per million) in the form of an odorant, so the SO<sub>2</sub> emission in its combustion is 150 times less than that of diesel oil and 2,500 times less than that emitted by high sulfur fuel oil.

Natural gas storability, its ability to be delivered through pipelines or liquefied form and sent by ship, as well as the ability of gas-fired power plants to turn on and off quickly, allow natural gas to respond to both seasonal and short-term demand fluctuations and to provide back-up to the growing use of intermittent renewables such as solar and wind power.

The natural gas market is increasingly globalized, driven by the availability of shale gas and rising supplies of tradeable liquefied natural gas. The growth of liquefied natural gas trade has created greater interconnectivity between markets, allowing supply flexibility from various exporting sources. Natural gas has the potential to be the transition fuel of choice for Cuba by accelerating the decarbonization of the electric power sector.



*Natural gas is a transition fuel that makes it possible to reduce the intensity of emissions from the energy sector and is an important source and a viable, affordable, and reliable option to accelerate the decarbonization process of some economies, always subject to its sustainable development.*

Ministerial Declaration, LI Meeting of Ministers of the Latin American Energy Organization (OLADE), November 24, 2021

## Natural Gas to Power

It is critical for Cuba to develop a baseload electric power system that offers the flexibility to operate on several diverse fuels, such as liquefied natural gas (LNG) and/or liquid fuels, in the case of emergencies. Fuel switching is a choice to be made based on available technology and on a fuel's btu value/price, fuel market availability, and associated environmental costs.

The global energy sector is undergoing a massive transformation due to increasing pressure to reduce carbon emissions and rapid and profound technological developments.

Cuba has to be very careful not to lock itself into inefficient technologies or outmoded power systems from countries that offer preferential financing terms and conditions or commit the government to politically fuel supply relationships, such as with Russia or Venezuela.

Today Europe is learning the hard way what happens to an economy dependent on fossil fuels supplied and controlled by a single import source. Europe is now paying the price of "putting all its eggs in one basket," Russia.

Cuba also has to be sure that new electric power plants do not become "stranded technologies," where the impact of new and more efficient future technology availability causes fossil fuel power plants to be decommissioned or underused.

For example, one path towards a reduced carbon energy system discussed today is the use of hydrogen as a gas turbine fuel. Hydrogen-fueled gas turbines could potentially allow both new and existing power plants to continue operating for decades to come, while reducing their carbon emissions.

Liquefied natural gas (LNG) could play an important role in Cuba's future energy mix. Cuba needs to decarbonize its electric power generation, while still providing reliable and cost-competitive power by investing in technologies that will make this possible while avoiding stranded assets as technologies change.





Thermoelectric Power Plant in Nuevitas, Camagüey, Cuba  
Photo by Rodolfo Blanco Cué, ACN

## Regional Gas to Power Case Studies: The Dominican Republic and Panama

Cuba could be categorized as a frontier market, a country that is more established than the least developed countries but still less established than emerging markets because it is too small, carries too much inherent risk, or is too illiquid to be considered an emerging market.

Is Cuba an attractive frontier market that meets private and multilateral financial institutions' investment criteria? Cuba must create an economic model that provides investors with an environment where they can conduct their business profitably and without unnecessary risks. Numerous business case studies show that some of the most important factors considered by investors as they decide on investment locations are:

- Market Size and Growth Prospects
- Creditworthiness
- Labor Availability and Skills
- Quality of Infrastructure
- Fiscal Terms and Conditions
- Trade Barriers
- Environmental Regulations
- Regulatory Enforcement
- Rule of Law
- Corruption and Governance Issues
- Stable Political Environment
- Physical and Personal Security

The use of LNG in electric power generation is growing in the region, as in Panama and the Dominican Republic. What makes these countries attractive to foreign investors willing to risk billions of dollars of capital in 20-to-30-year horizons? It merits to evaluate how some of these projects came about, particularly reviewing the legal and fiscal models developed by the host governments to attract foreign investors and the support of multilateral institutions to execute these projects.

## Moving Forward

Cuba should consider, under a decentralized economic and market model, the use of Public-Private Partnerships (PPPs), agreements between the government and the private sector to design, finance, build, operate, and maintain public infrastructure projects such as electric power generation.

According to the World Bank, when designed and implemented within a balanced regulatory environment, PPPs can bring greater efficiency and sustainability to the creation of public services such as electric power generation.

Cuba's *Servicio Eléctrico Nacional* (SEN) high sulfur liquid petroleum fuels fired base load electric power infrastructure is old, tired, and highly inefficient. Years and billions of dollars would be needed to reconstruct its thermoelectric baseload and distributed generating capacity and achieve the government's stated goal of 37% of renewables within its electric power sector energy matrix.

Because the operating conditions of Cuba's current thermoelectric base-load, distributed energy, and/or renewables (solar and biomass) are unknown, I have assumed a worst case "greenfield" recapitalization estimate of \$8-10 billion dollars within a five-to-ten-year period.

Cuba faces two significant obstacles in recapitalizing its power system: time and money. To overcome these obstacles, the government must decentralize its economic model and resolve its political differences with the United States.

Cuba has to abandon its failed Soviet-style centralized command economic model based on state ownership of all means of production and industrial transformation. It should welcome a market economic system in which the decisions regarding investments and production are guided by supply and demand market forces.

Also, a political solution has to be found to The Cuban Liberty and Democratic Solidarity (*Libertad*) Act of 1996 (Helms-Burton Act), which codified into law several economic, financial, and commercial sanctions against U.S. and foreign companies trading with Cuba.

Secure, efficient, and clean energy is critical to a nation's economic and social development. It is vital to ensure a positive impact on people and their environment and the quality of public services such as public health and education.



# Conclusion

Cuba needs to develop a clear and comprehensive 2030 energy roadmap to achieve and maintain the reliability and sustainability of the electric power sector value chain within a decentralized economic model, while contributing to the competitiveness of the national economy through five critical pillars:

- **Energy Security:** a balanced fuel mix strategy with the ability to manage risks due to changes in price, geopolitical events, and/or supply-demand disruptions.
- **Reliable Energy:** uninterrupted infrastructure performance and the ability to quickly facilitate recovery from energy transmission and distribution disruptions from technical breakdowns or natural disasters.
- **Clean, Sustainable Energy:** a balanced energy matrix of renewable sources such as wind, solar, and biomass, and low carbon fossil fuel baseload generation.
- **Energy Efficiency:** policy, fiscal, and regulatory programs focused on reducing the amount of energy required to provide goods and services by promoting capital investments in energy-efficient processes in industrial transformation, transportation infrastructure, and commercial and residential building construction.
- **Energy Conservation:** policy, fiscal, and regulatory programs focused on reducing energy consumption, such as using less electricity and transportation, and creating public awareness through energy education programs.

## FIU CasaCuba

CasaCuba at Florida International University is bringing together scholars, policymakers, business leaders, students, and the community at large to realize a multidimensional Cuban cultural center and think tank that facilitates the discussion and study of Cuban affairs - history, policy, business - and the celebration of the Cuban heritage. CasaCuba has attracted influential board members, recruited a uniquely qualified team, secured a prominent site on campus, and received significant philanthropic support, including prestigious grants from the National Endowment for the Humanities, the John S. and James L. Knight Foundation, and the Florida Division of Arts and Culture of the Florida Department of State. CasaCuba will feature galleries for interactive exhibits, as well as a state-of-the-art venue for events, performances, and dynamic programming.

## Cuban Research Institute

FIU's Cuban Research Institute (CRI) is dedicated to creating and disseminating knowledge about Cuba and its diaspora. The institute encourages original research and interdisciplinary teaching, organizes extracurricular activities, collaborates with other academic units working in Cuban and Cuban American studies, and promotes the development of library holdings and collections on Cuba and its diaspora. Founded in 1991, CRI is the nation's premier center for academic research and public programs on Cuban and Cuban American issues. No other U.S. university surpasses FIU in the number of professors and students of Cuban origin.

## Kimberly Green Latin American and Caribbean Center

The Kimberly Green Latin American and Caribbean Center (LACC) at FIU was founded in 1979 to promote the study of Latin America and the Caribbean in Florida and throughout the United States. By forging linkages across the Americas through high quality education, LACC's research is aimed at better understanding and addressing the most urgent problems confronting the region. LACC is designated by the US Department of Education, funded by Title VI, as a National Resource Center on Latin America, recognizing it as one of the top Latin American and Caribbean Centers in the country. LACC draws upon the expertise of one of the largest concentrations of Latin American and Caribbean Studies scholars of any university in the country, spanning a multitude of disciplines across colleges.

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