ROOT CAUSE ANALYSIS OF ENERGY CONSTRAINT

Version 1.12.22

Belize Compact Development Program

Electricity Cost Root Cause Analysis

Acronyms

BCCI - Belize Chamber of Commerce and Industry
BCDT- Belize Compact Development Team
BEL - Belize Electricity Limited
CFE – Commission Federal de Electricidad (MEXICO) (Mexico's Federal Electricity Commission for its translation in English)
DER - Distributed Energy Resources
EE – Energy Efficient
GOB- Government of Belize
IPP - Independent Power Producer
MCC – Millennium Challenge Corporation
MSME - Micro, Small and Medium Enterprises
NEP – National Energy Policy
PPA- Power Purchase Agreement
PUC - Public Utilities Commission
RE- Renewable Energy
RFP - Request for Proposal

I. Executive Summary

With a per capita GDP of BZ$11,464 in 2021, Belize is classified as an upper-middle income country (World Bank, 2021). Between 2001 and 2019, growth fluctuated and averaged only 2.1%, and per capita income remained stagnant. The most recent analysis of the country's growth impediments completed by the Millennium Challenge Corporation (MCC (2022) identified five development constraints: access to finance, natural capital management, government regulation and tax policy, education, and electricity costs. The purpose of this Root Cause Analysis (RCA) is to identify the root causes of electricity costs so that interventions can be designed to address them.

According to the RCA, the cost of electricity drives up input costs in all industries thus identified as a cost to economic growth. Moreover, the reliance on imported electricity at spot market prices results in low investor confidence in energy-intensive industries due to uncertainty regarding future electricity prices. This limits the profitability of companies, preventing them from expanding and creating additional jobs. Belize Electricity Limited (BEL) has not signed contracts to significantly expand its cost-effective renewable energy portfolio even though the government's Sustainable Energy Roadmap 2021-2040 calls for investment in cost-competitive renewable energy. Consequently, residential and commercial rates per kilowatt hour (kWh) remain high in Central America, limiting users' disposable income and consumption. In vulnerable groups, this reduces their purchasing power, which prevents them from affording healthy foods, education, and healthcare.

BEL owns and operates all transmission and distribution assets, and it purchases electricity from nine local and one international International Power Producer (IPP). In the past decade, Mexican electricity has provided 45.4% of the country's electricity needs, with hydroelectric power accounting for 35.2%. Biomass generation accounts for 12.3%, gas turbines for 6.0%, and solar power for 0.2%. (BEL Annual Report, 2021). As a result of its import reliance, the country faces energy security issues, oil price shocks, and Mexican demand conditions, while the hydroelectric facilities are suffering from climate change conditions, including flooding and droughts, which generally affect BEL financially. Approximately 60.0% of the wholesale electricity tariff is attributable to unfavorable pricing from these IPPs**.**

For the past five years, the most expensive source of power for BEL has been Fortis hydroelectric power (BZ$0.25 per kWh), followed by BELCOGEN biomass power (BZ$0.22), and Federal Electricty Commission (CFE, for its acronym in spanish) at (BZ$0.20). As a result of limited resources and human capacity, governmental authorities lack the capabilities for oversight, integrated resource planning, policy coordination, and enforcement. In order for the energy sector to adopt appropriate technological adaptations, it needs to build up its knowledge capacity. Additionally, the grid must be updated to accommodate changes in demand and technological advancements in electricity production, as subpar systems lead to further inefficiencies which contribute to the elevated costs of electricity for all consumers. Some of these factors include legacy contracts; structural inefficiencies related to oversight by the regulator and its enforcement capacity; inadequate transmission capacity and grid resilience and challenges to bringing in low-cost power.

Several Power Purchase Agreements (PPAs) are currently structured to favor individual IPPs, with these costs passed on to consumers, keeping tariffs high. Rates being charged by IPPs are not based solely on power production costs (PUC, 2022). By 2021, various additions to the cost of energy supplied to BEL by the Fortis hydro producers included capacity payments, dam spillage clauses, and escalation clauses and resulted in prices that were almost twice as much as the energy imports from Mexico per kWh (BEL, 2022). Similarly, production costs from BELCOGEN, the biomass producer, have also increased since Fortis has power purchase agreements (PPAs) for its hydro dam with BEL that won't expire until the 2050s, while the terms of the biomass contract will be negotiated in 2024. The government of Belize had to rescue BSI (ASR). 40% of money needed had to go to the sugar plant itself to renovate the plant. So the cost of what was required for the power plant and what was required for the sugar plant was combined into one power purchase agreement and this was called "recovery of capital for the power plant. The power plant was taxed to save the sugar industry; therefore, the price is an inflated price (PUC, 2022)." In addition, Fortis has power purchase agreements (PPAs) for its hydro dam with BEL that will not expire until the 2050s, while the terms of the biomass contract will be open to negotiations in 2024.

In addition, BEL has enjoyed a similar special arrangement in the case of its General Electric LM2500 unit at Mile 8 on the George Price Highway. The cost performance promised by the utility in its 2003 filing has never been attained, thereby severely limiting the dispatching of that unit when wholesale prices in the spot market are elevated. This substandard performance at mile 8 is explained as a charge that is passed on to rate payers, as the law stipulates that the PUC must establish the standards of performance of the services supplied and determine the reasonable cost for delivering the service. Instead the PUC just dealt with the cost side and not the standards side of the operation of the gas turbine at mile 8. So the gas plant did not perform. There were lots of blackouts. No regime was established as to how the gas plant was supposed to perform (PUC 2022)."

Structural inefficiencies related to oversight by the regulator and its enforcement capacity manifests itself through limited policy, planning, procurement, and oversight capability within the government agencies, along with technical capacity gaps at all levels which have contributed to several governance issues giving rise to the potential for ineffective performance and conflict of interest in the sector. The latter is perceived to have caused irregularities in terms of the dispatch of power sources, with high-cost alternatives given preference over other lower-cost power producers at times (PUC, 2022). When the new PUC Commissioner took office in December 2020, many strides have been taken to change the PUC into an organization where its power can be duly enforced. Examples include drafting of the RFP regulations which are at Attorney General's desk for review. Thereafter they will be passed on to the House of Representatives for "no objection." These regulations ensured that the conflict of interest scenario was addressed. In addition, the PUC has expressed a strong interest in commissioning a comprehensive Cost of Service Study which will research rates paid by partial use customers. The costs in this study will help to inform the net billing regulation, which is an essential link to the uptake of RE take up in Belize. DER developers need price signals on their value proposition. This Cost of Service Study will include recommendations for an optimal legal framework to address the present monopoly situation exercised by the distributor. A competitive market design and industry structure is one of

the objectives of this Cost of Service study. The 2017 Cost of Service Study was a desk review which provided little in terms of helping to keep up with the dynamic changes in the electricity market. In addition, production costs from BELCOGEN, the biomass producer, have also increased and since Fortis has power purchase agreements (PPAs) for its hydro dam with BEL that won't expire until the 2050s, while the terms of the biomass contract will be negotiated in 2024. Additionally, the Ministry's Energy Unit needs to formulate and implement a sound, realistic and viable energy policy and plan the requisite resource adequacy. Limited financial resources, deficits in the supervisory structure, and legislative authority to oversee the tendering process prevent the ministry from implementing properly integrated resource planning and other important operational decisions in the market.

Belize currently lacks sufficient transmission capacity to plan future domestic generation growth with intermittent renewable energy that would have lower prices plus incorporate grid resilience. The Mencias and Esquivel study in 2008 noted that the sole transmission line coming from Mexico (Xul-Ha) has limitations, which if remedied can provide over USD $3.0mn in savings annually. These operational issues created heightened administrative costs for the distributor, which is included in the tariffs being charged to consumers as well. An additional transmission line from the Xul-Ha node in Mexico would help alleviate the limitations cited above, however, a second line to a different interconnection station could yield additional savings, efficiency, and resilience. Additionally, it opens the possibility to invest in larger power production facilities in Belize, which could affect the per-unit price of installed capacity.

The process of bringing new, cost competitive IPPs online has been impaired by the practice to relegate this function to the distributor, instead of the sector's oversight entity posing challenges to objectively reduce the cost of electricity. Recently, a Least Cost Expansion Plan was commissioned and financed by the distributor independently, a function typically managed by the government oversight agencies thus limiting their participation. The lack of human and financial resources of these agencies, and the ad-hoc manner of industry operations create inefficient ecosystems with limited alignment with national interests. The distributor has not been able to finalize an IPP selected at the last competitive RFP in 2014, despite it being a renewable source, in line with government policies. The distributor has not filed a grid modernization plan with the PUC which is of concern as the interest is in renewable energy projects in Belize which will interact with the grid. The PUC has repeatedly requested that BEL file for the Commissioner's review and approval its Dispatch and Production Costing Code. BEL has never complied. At the end of each year the PUC has requested from BEL a report on network bottlenecks and constraints that were observed during the recently concluded operating year. In particular the PUC is trying to understand the boundary conditions at key nodes. BEL has never responded to the PUC's request. The PUC can escalate unfulfilled license obligations of BEL to an order. Additionally, no significant headway has been made in the development of a timely plan to commence distributed generation domestically and in the possible construction of an additional transmission line from Mexico. The latter could provide reliability benefits as well as increase Belize's climate resiliency during hurricanes and climatic vulnerabilities such as flooding and increased fire occurrences.

II. Background and Technical Overview

Background

Belize, by virtue of having a GDP per capita of BZ$11,464 in 2021 can be defined as an upper-middle income country by World Bank classifications. It is a small, open, and services-oriented economy complemented by agriculture, commercial fishing, and manufacturing industries. Within its services sector, international tourism is the cornerstone, accounting for a significant share of GDP. Belize's economy has experienced major shifts in productive sectors and employment patterns in recent decades. Data from the Statistical Institute of Belize show that the share of GDP from the service (tertiary) sector increased from 62% to 71% between 1997 and 2017, while the share from the primary and secondary sectors declined from 18% to 13% and 20% to 16% respectively. Likewise, during the same time period, the service sector's share of employees increased from 56% to 65% of the labour force, while the primary and secondary sector's share went from 28% to 18% and 16% to 17%, respectively. In addition, Belize's economy is vulnerable to economic shocks stemming from climate change, natural disasters and adverse economic conditions affecting tourism markets like the United States. Other economic concerns include foreign reserve adequacy linked to an increasing dependence on imports and the government's long-term debt sustainability. In terms of the former, the economy engages in the exportation of raw primary products which are lower on the value chain and imports higher value-added goods for consumption. As for the latter, recent developments including the re-basing of GDP (2022) and restructuring of external debt have contributed to a considerable improvement in its debt-to-GDP ratio (debt ratio). However, given the frequency of global economic shocks, and the weather-related issues that Belize has faced , the economy has stagnated in terms of real GDP growth within the past two decades and most recently with the global pandemic reducing the country's income classification in 2020.

Several examinations of the country's growth diagnostics have been completed in Belize since 2007, including Hausmann and Klinger (2007 & 2010), Martin (2015), IMF (2019), and most recently the MCC (2022). Common constraints identified in the previous studies included the inadequate operations of the financial sector, fiscal discipline, education, crime, and vulnerability to climate change. The MCC, after multisectoral stakeholder consultations, desk reviews, and data analyses, identified five binding constraints namely: access to finance; natural capital management; government regulation and tax policy; education, and the cost of electricity. We will focus on stimulating economic growth and removing impediments to it. In order to uncover the root causes of this growth impediment, the Belize Compact Development Team (BCDT) and MCC team will focus on the cost of electricity.

Cost of Power Constraint and its Impact

Core Problem: The cost of wholesale electricity is higher than it should be when compared to a well- functioning market in electricity.

During the constraint analysis, several local businesses, ministries, and professional associations were engaged and most of them cited that the cost of electricity was an impediment to business development in the country. According to a 2010 Enterprise Survey, 68.8% of Belize's large businesses cite high electricity costs as a major constraint on their business, indicating that larger and more energy-intensive firms would have greater difficulties in their business operations. As a

result, these firms maintain similar levels of employment within their industries while maintaining lower production levels, lower profits, and limited reinvestment. Additionally, there is also evidence that higher costs of energy affect the profitability of Micro, Small and Medium Enterprises (MSMEs) and the productivity of farm enterprises[1]. Furthermore, the reliance on Mexican imports at volatile spot prices damages investor confidence in energy-intensive businesses, lowering the propensity to invest in these firms. This all translates into the broader economy by constraining the aggregate investments by businesses, households, and investors which prevents the diversification of production, leading to fewer value-added goods in the market. Furthermore, maintaining employment levels at just above 160,000 (an average for the past five years), leads to a fall in consumption, all resulting in a contraction in economic growth.

From a household's perspective, the high cost of electricity as an impediment to economic growth is manifested in a different way. There are disparities in access, based on social standing and location as 40% of poor households have no access to electricity, while the Toledo District at 29% has the lowest rate of access (Data Source). Despite these discrepancies, the poor who do have electricity also have issues with the cost of power as this expenditure typically exhausts a larger proportion of their wages. These individuals either because of their lower salaries, faulty electricity fixtures, or lack of access to energy-efficient (EE) appliances tend to have unreasonably high electricity outlays. The high cost of electricity affects the poorer households by reducing their buying power for food and other essentials. The former will reduce overall consumption levels due to high prices and reduces economic growth through that channel, while the latter affects other development outcomes, namely health and nutrition which impedes economic growth by limiting worker availability and reducing worker hours.

The Energy Unit's 'Sustainable Energy Roadmap 2021-2040' encourages private sector investment in cost-competitive renewable energy sources to come on stream, however, there has not been a successful Request for Proposal (RFP) that has resulted in the commissioning of an independent power producer (IPP) on Belize's grid since 2013[2]. Belize Electricity Limited (BEL) has currently not signed any Power Purchase Agreement (PPA) to significantly expand cost-effective renewable energy in the country. Accordingly, the cost per KWH remains slightly higher than average when compared to a selected group of nations from Latin America and the Caribbean, but notably higher than average when excluding island nations (which have unique power costs), (Figure 1). Likewise, the residential rates are also much higher than in most other Central American countries as well with the exception that Guatemala residential cost is much higher (Figure 2).

[1] In Belize, many rural households without electricity access use kerosene as a source of energy, which is more expensive

[2] This date refers to the year of the RFP and not the year in which the IPP came into operations in the electricity sector of Belize

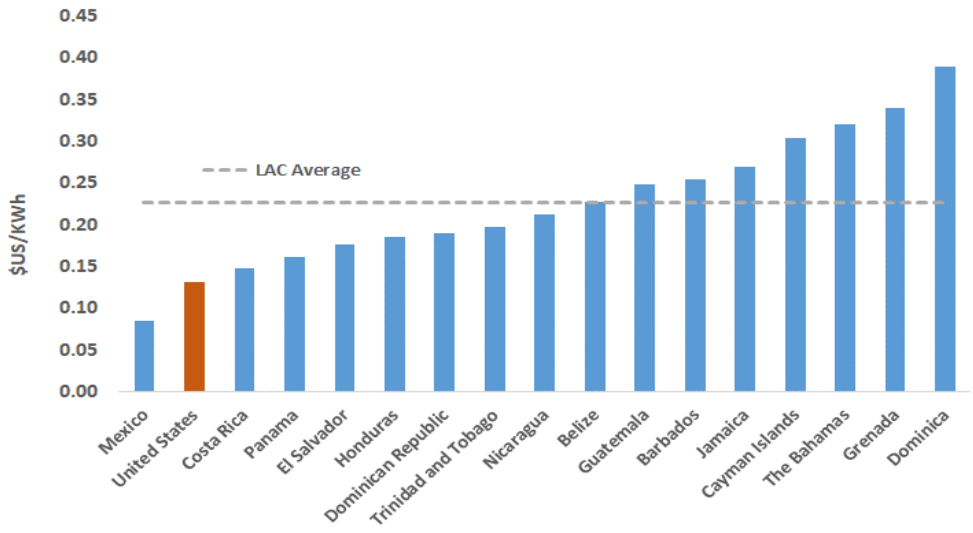
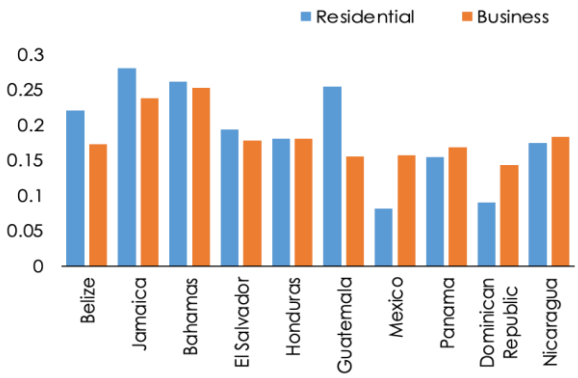
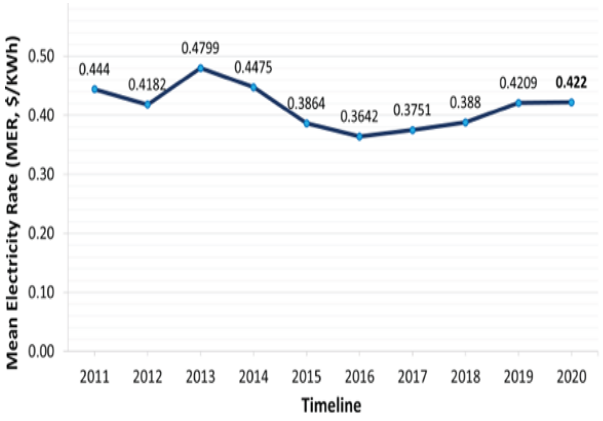


Figure 1: Comparative Electricity Tariffs of Selected Nations





Electricity Sector Historical Summary

The generation of electricity countrywide was initially done with separate diesel generators by the Belize Electricity Board, a government monopoly, however, in 1991 contracts were signed to build a hydro facility on the Macal River at the Mollejon site. During that time, the Electricity Act (Act) was passed in 1992 creating a regulator (The Office of Electricity Supply) to encourage private sector participation in the industry. Simultaneously, the Electricity Board was privatized and became Belize Electricity Limited (BEL, 2000) with the government holding majority shares (51 %) in the institution and the rest made available to the private investors though they were limited to a maximum of 25% of the outstanding shares individually. In 1995, a year before the 25-Megawatt hour (MW) dam was commissioned at Mollejon, a 12-year bilateral agreement was

signed between the governments of Belize and Mexico for the sale of electricity between the country's two power companies, CFE and BEL.

The agreement to construct the hydro facility eventually resulted in the formation of BECOL, a subsidiary of Duke Energy that built and operated the Mollejon station and a transmission line along Belize's central corridor from Cayo to the Belize District. This line was transferred to BEL at concessionary rates ($1.00 reportedly), but the recovery of its cost was built into the price paid for Mollejon's power. The bilateral agreement between neighboring governments became the basis for the construction of the 115kV transmission line between Xul-ha and the Belize District, and when operations commenced in December 1999, several of the diesel power stations were decommissioned. During that year the Public Utilities Commission (PUC) was created, and the Act was amended to give the commission jurisdiction over the electricity sector, though, at the same time, a majority stake in BEL was sold to Fortis Incorporated (Canada), with the articles of the Act amended ex-post to allow the transaction. Fortis later acquired BECOL from its previous owners, and the PUC approved the construction of the Chalillo dam for the company and extended the terms of their power purchase agreements (PPAs) with BEL from 2036 to 2055.

Several requests for RFPs were completed resulting in the commissioning of several other IPPs, including Hydro Maya and BELCOGEN (biomass) in 2003, Vaca (hydro) and BAPCOL (fossil fuel) in 2005, and the last successful one in 2013 which ended up in the commissioning of Santander (biomass). During 2014 there was an additional RFP in which BAPCOL won a solar bid and a hydro bid was also awarded, but both have yet to come on stream for various reasons. During that time there have been numerous developments in the sector including the setting of license terms for hydro (50 yrs) and other technologies (15 yrs), the PUC 'delegating' its responsibility for promoting competition in electricity generation to BEL (s. 7 of Electricity Act), and most importantly, GOB's nationalization of BEL, resulting in the acquisition of 63.8% of the majority of its shares (GOB direct ownership of 32.6% interest in the Company and the Social Security Board ownership of 3.8 % in 2011. GOB has worked on a National Energy Policy (NEP) for Belize on two different occasions, one in 2012 and another that is currently being developed. However, there have been issues in implementation of the 2012 NEP given the lack of capacity and financial resources within the ministry in charge of energy and the PUC. In the second stakeholder consultation for the National Energy Policy, a recommendation is being made to make the Energy Unit an Energy Department, thereby allowing it to more freely exercise its power.

Belize's Existing Electric Sector

The electricity sector is currently being overseen by the GOB, through its Energy Unit and PUC, with the former housed in the Ministry of Public Utilities, Energy, Logistics and E-Governance (MPUELE). The Energy Unit's main functions include planning, promoting, and effectively managing the production, delivery, and use of energy through energy efficiency, renewable energy, and cleaner production interventions. One of their main outputs is the National Energy Policy Framework, which effectively plans the course of the industry and its development based on projected demand, using renewable energy sources.

The PUC is the supervisory arm of GOB's functions, as it oversees the sole distributor and all the IPPs by evaluating their operations and issuing licenses for such. Perhaps their main role within the industry, which is highlighted most of the time is their tariff-setting function within the industry, as the PUC evaluates the tariff proposal brought in by the distributor and either approves or revises them based on the best information available.

BEL is the sole distributor of energy and is the owner of the transmission and distribution network. They are the only customer-facing segment of the industry, which means that the delivery of electricity to the end-use customers is a monopoly franchise, with BEL playing a big role in determining tariffs across different customer segments. This lack of a competitive market structure in transmission and distribution contributes to the high cost of electricity. The dispatch of generation is centrally controlled by BEL, with hydroelectric production optimized across wet-dry seasons, variable renewables (biomass from sugar mills) taken as produced, and all other sources to be dispatched in merit order. There is limited reliance on daily market interactions, except when BEL trades in Mexico's power pool. Despite being authorized in the legislation to oversee the industry, the Energy Unit and the since BEL has operated with high levels of autonomy within the industry with limited oversight, it is considered the de facto leader of the industry since it negotiates PPAs, develops expansion plans, and attracts IPPs online (see Table 1).

Table 1: Summary of Responsibilities of Electricity Sector

Industry Participant	Responsibility Summary
Energy Unit	Partially responsible for the oversight of the system's participants and overall policy for sector.
Public Utilities Commission	Supervises the operations of the electricity sector, conducts tariff review and determination, provides new resource procurement guidelines, approves PPAs, and issues production licenses for IPPs.
BEL	Owner and operator of the transmission and distribution system, conduct system operations and dispatch, negotiates PPA's and signs agreements, funds expansion planning and Cost of Service analysis
IPPs	Produce electricity and sell to the grid, upkeep of their production systems and networks

Lastly, there are ten IPPs whose job is to generate electricity and sell to the distributor, which includes negotiation of selling prices and other details agreed upon in the PPAs. These utility-scale electricity providers are granted an authorized area, which means that a person authorized by a license to supply electricity is designated an area to supply any and all premises in that designation (see Figure 3).

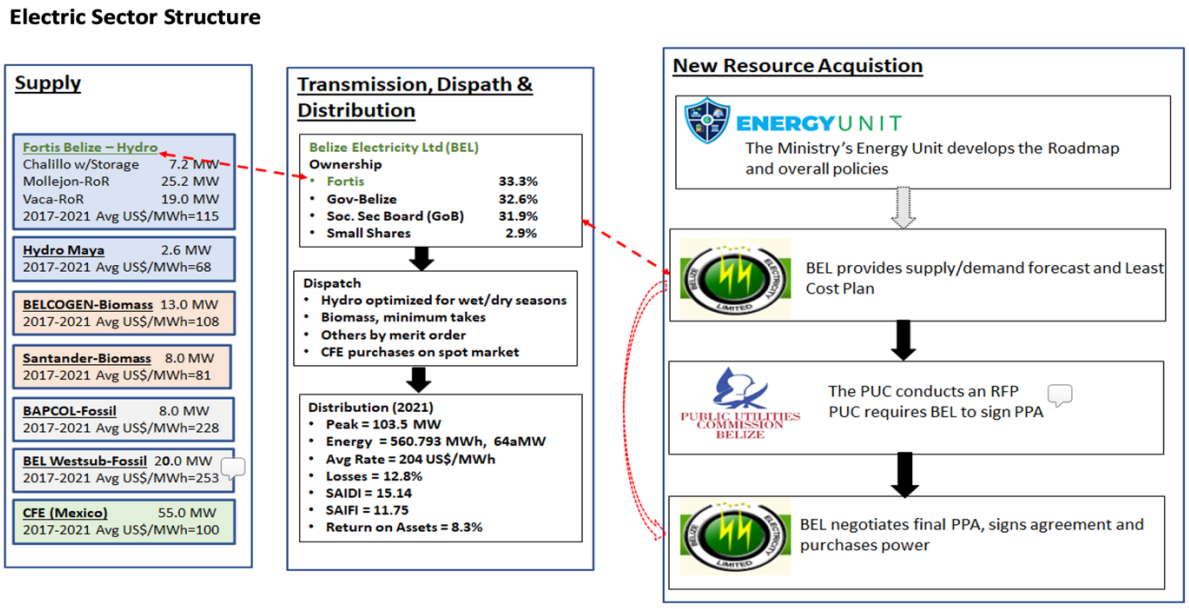


Figure 3: Electricity Sector Structure

Planning for new investment is done using demand forecasts rather than through price signals, as the distributor provides the PUC with supply and demand forecasts over a minimum 10-year horizon. This means that the level of required electricity supply capacity is administratively determined by the regulator. Procurement for the new generation, including associated auxiliary services, is done through competition among private sector participants. Firstly, the PUC conducts an RFP for the required capacity determined in the planning process and then requires BEL to sign them with successful developers. These IPPs are usually paid under long-term contracts by the single buyer with PPAs that are typically for 15 years but may be extended for the economic life of the generation plant. This is often described as competition for the market, in contrast to competition in the market, (Belize Ministry of Energy and Public Utilities, 2021). However, in past procurements, BEL has objected to contract terms and no contract was signed and generation supply was not procured (PUC 2022).

There are currently ten different IPPs in the network and they are characterized by different ownership, capacity, energy source, and the way in which they are utilized in the system. These are shown in Table 2 below. When aggregated by energy source, the domestic generation is buoyed by hydroelectricity production with the four plants mostly available during the second half of the year during Belize's 'rainy' season. Biomass production places a distant second, with their output mirroring that of the sugarcane season in the country with the two IPPs generating power from the waste product bagasse. Additionally, there is limited generation from fossil fuels and solar energy. Belize is mostly dependent on fuel imports from CFE in Mexico, but it has been difficult to properly decipher the source of its generation.

Table 2: Supply Resources Characterization

Producer/Plant	Energy Source	Type	Availability	Effective Capacity (MW)	Plant Owned by
BECOL - Mollejon	Hydro	Renewable	Annual	25.2	IPP
BECOL - Chalillo	Hydro	Renewable	Annual	7	IPP
BECOL - Vaca	Hydro	Renewable	Annual Tables	19	IPP
CFE	Energy Import		Annual	55	IPP
Hydro Maya (HML)	Hydro	Renewable	Annual	3.45	IPP
BELCOGEN	Co-generation/ Biomass	Renewable	Seasonal(March-June)	13.5	IPP
BAPCOL	Fossil Fuel-HFO	Non-renewable	Annual	22.5	IPP
Santander (SS)	Co-generation/ Biomass	Renewable	Seasonal(January-August)	8	IPP
Gas Turbine (GT) [BEL owned]	Fossil Fuel-Diesel	Non-renewable	Back-up (Emergency)	20	**BEL**
CCK Plant [BEL owned]	Fossil Fuel-Diesel	Non-renewable	Annual	4.1	**BEL**
JICA	Solar	Renewable	Annual	0.45	IPP

Table 3: Electricity Generation by Type of Production and Cost

The country currently imports up to 50MW of electrical power from the national utility of Mexico, CFE, via a 115 kV transmission link that interconnects the national grids of both countries. The supply of electricity from Mexico has been underpinned by four contracts made directly between CFE and BEL, though the arrangement is based on the bilateral relationship between the two countries. CFE sells energy to BEL on the spot market, though the purchasing mechanism allows for bids to be placed the evening prior to the transaction. In the agreement, there are also clauses and transactional arrangements for the exchange of power between the parties during times of emergency, including hurricanes and other natural disasters. The Firm Capacity and Associated Energy Supply agreement and the Economic Energy Purchase agreement together stipulate the terms and conditions, particularly the charges, for the purchase of capacity and energy under normal conditions.

Hydroelectricity generation is the country's second-largest source of power, with three out of four plants producing the bulk of the energy, all situated on the Macal River, the most developed watershed. The dam at Chalillo (6 MW) feeds a cascade of two downstream plants, with Mollejon, which has a potential of 25 MW being next, and Vaca (6 MW) immediately below. The Columbia River (Hydro Maya) has the lowest cost generation facility in the country, but the scheme is a run-of-the-river. The country has two cogeneration plants that both operate by burning bagasse, the waste product during the sugar production process. Currently, there is BELCOGEN production at Tower Hill (13.5MW) and Santander (8 MW) in the Cayo District, with the constraint being the availability of feedstock all year round. There are two fossil fuel producers, BAPCOL (22.5 MW) and BEL-owned gas turbine at Mile 8 (20 MW) in the Belize District. Typically, the role of oil-fired power plants is to supply peaking demand during the dry season but slip to the provision of supplemental reserves during the wet season. However, under drought conditions, these power plants move up to mid-merit in the dispatch, as occurred in 2019, (Belize Ministry of Energy and Public Utilities, 2021. Lastly, there is one solar generation plant that operates on the University of Belize Campus in Belmopan, but their production is negligible at 0.5MW (see Table 3 and Figure 4).

Table 4: Electricity Generation by Type of Production and Cost

Fuel Type	US$/MWh	kWh (2020)	% kwh	Total US$	% Total $	Capacity (MW)	Load Factor
Fossil	229.6	19,554,645	3.2%	4,488,769	2.4%	46.6	4.8%
Hydro	158.1	241,986,383	39.4%	38,245,948	20.8%	54.7	50.5%
CFE	147.3	270,238,872	44.0%	39,806,186	21.6%	55.0	56.1%
Biomass	116.7	81,332,690	13.3%	9,487,458	5.2%	21.5	43.2%
Solar	87.9	568,488	0.1%	49,970	0.0%	0.5	14.4%
Avg Retail Tariff	199.5						

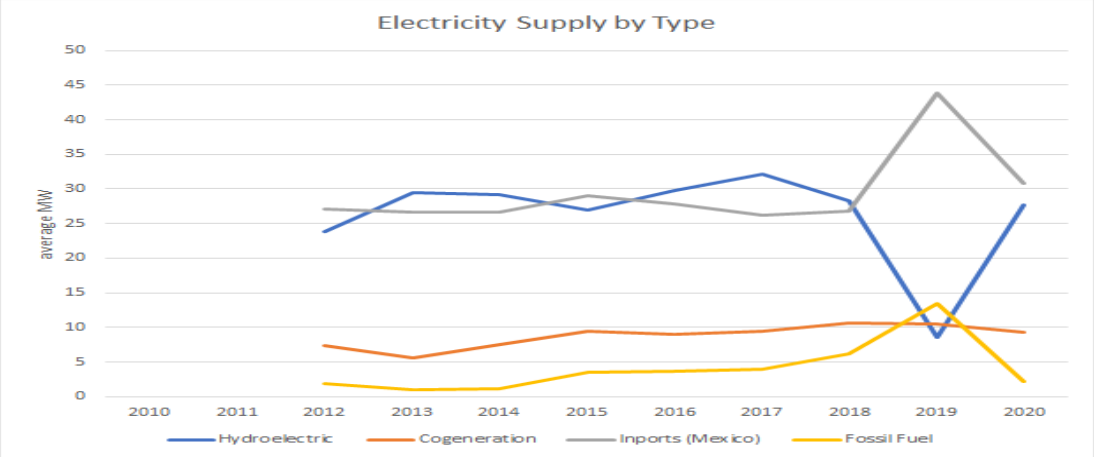


***Figure 2*: Electricity Supply by Type**

Over the past ten years, the country has been reliant on electricity from CFE (44.4%) and hydro facilities (35.2%), with biomass (12.3%), gas turbines (6.0%), and solar energy (0.2%) providing the remainder (BEL Annual Report, 2022). With most of the power being supplied by CFE, risks include exposure to oil price shocks, and demand conditions in Mexico, which have manifested in the scarcity of natural gas deliveries to combined cycle power plants on the Yucatan Peninsula,

which elevated prices between 2017 to 2019. Concerns have been expressed regarding energy security issues that can arise, with the national power company supposedly giving preference to the Mexican public over Belize. The hydro plants in Belize face other risks including climate change, with the frequency of droughts and flooding becoming unpredictable. Seasonal output from the sugar mills complements the typical seasonal variability of hydroelectric production; wherein when hydroelectricity output is down during the dry season, sugar mills are at their maximum, and vice versa.

III. Tracing the Root Cause of the Constraint

Prior to the start of the stakeholder engagement, the common root causes of the high cost of electricity were examined and the following factors identified were identified:

- Unreliable on-grid power supply
- Inadequate transmission and distribution network capacity
- Insufficient supply from domestic generation facilities
- Insufficient investment toward generation facilities by Independent Power Producers
- Non-cost-reflective tariffs
- Insufficient supply from imports
- High transmission & distribution technical losses
- High cost of power to on-grid consumers (high retail tariff and high backup generator use)
- Low access to power (low electrification rate)
- The cost of connection and tariffs are very high
- Barriers and inadequate incentives for Private Sector Participation

Three root causes were selected and were further evaluated.(See Figure 5)

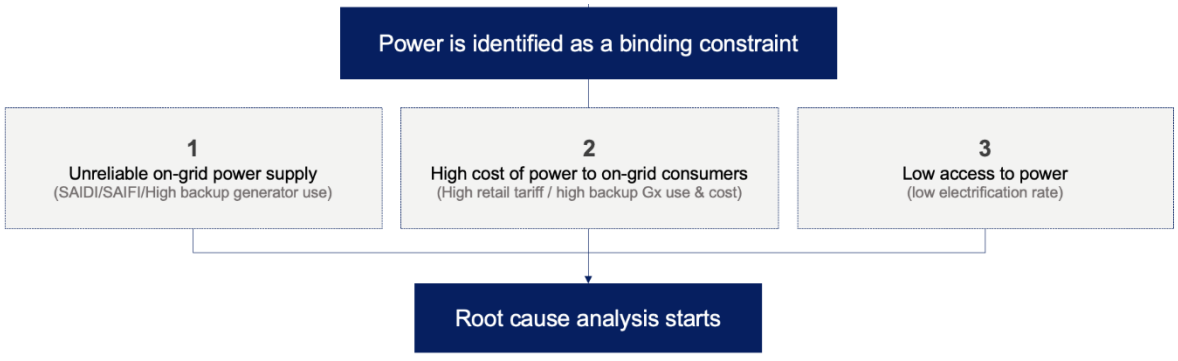


Figure 5: Potential Root Causes of the High Cost of Power in Belize

Further examination of data sources led the teams to remove root cause three from further analysis as data confirms that 92% of the Belizean population has access to electricity from the grid (BEL, 2022). There were discrepancies in access identified based on location and social status, however,

the extent of the population utilizing alternative sources of expensive energy off-grid is not as significant and wouldn't contribute to the high cost of electricity generated from the grid. The remaining two root causes were further examined based on the two following diagrams. Figure 6 shows the breakdown of the 'unreliable on-grid power supply' root cause, which required the team to analyse the demand and supply dynamics in the electricity sector, the characteristics of the transmission and distribution network, and their associated costs. The 'high cost of power to on-grid consumers' root cause (Figure 7) focuses on the factors that influence the level of the retail tariffs, namely what contributes to the generation, transmission, distribution, and administrative costs of the system and how they translate into the prices paid by end users.

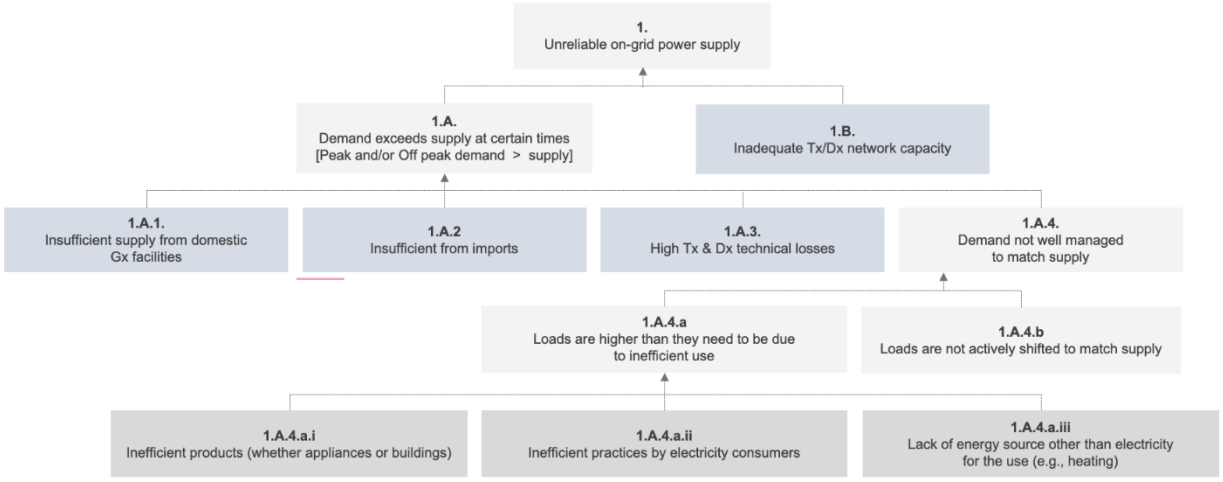


Figure 6: Breakdown of Unreliable On-Grid Power Supply Root Cause

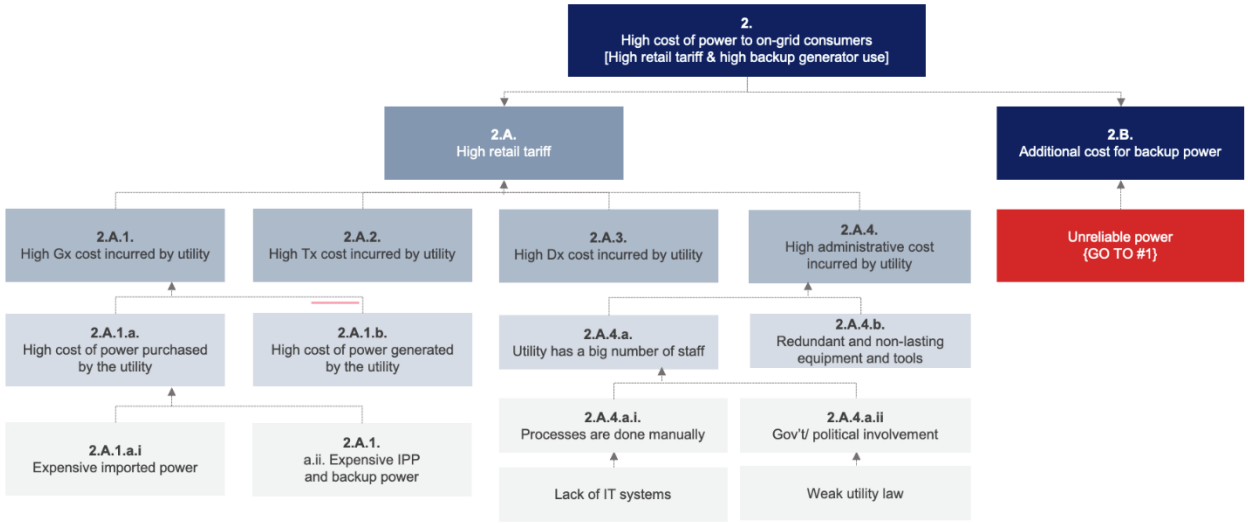


Figure 7: Breakdown of High Cost of Power to On-Grid Consumers Root Cause

IV. Root Cause Analysis

Unreliable On-Grid Power Supply

In order to identify the causes of the high electricity cost in the system, the team analyzed all the branches of the root cause problem tree. In order to evaluate the reliability of the on-grid power supply, two main components had to be evaluated: the demand and supply in the system and the transmission and distribution system. Below is a breakdown of the former.

Demand Exceeds Supply at Times:

Belize has a small population, which leads to comparable production levels, so the demand for electricity is not expected to exceed the supply. The addition of BEL diesel generation, which will only be deployed in an emergency, should allow the system to meet the supply requirements within various periods of time when demand for CFE begins to rise. BEL reports that since 2012, no shortfalls have been recorded between electricity generation and consumption by customer categories.

Additionally, the diesel generation from BEL has been operating way below its capacity, which could have contributed to additional electricity generation, if necessary, indicative of the adequacy of the supply of energy. The PUC during stakeholder engagements has also mentioned that the capacity can become an issue for Belize when the country breaches 110MW in its peak load. The data has shown that the country is trending towards that value (See Figure 8), with the rise in capacity utilization most outstanding during the summer months and during the Christmas season (PUC, 2022). CFE is providing for the peak load at this time, and technically it is believed that the transmission line can move up to 70MW at any point in time, however, it has been operating at a maximum of 55MW.

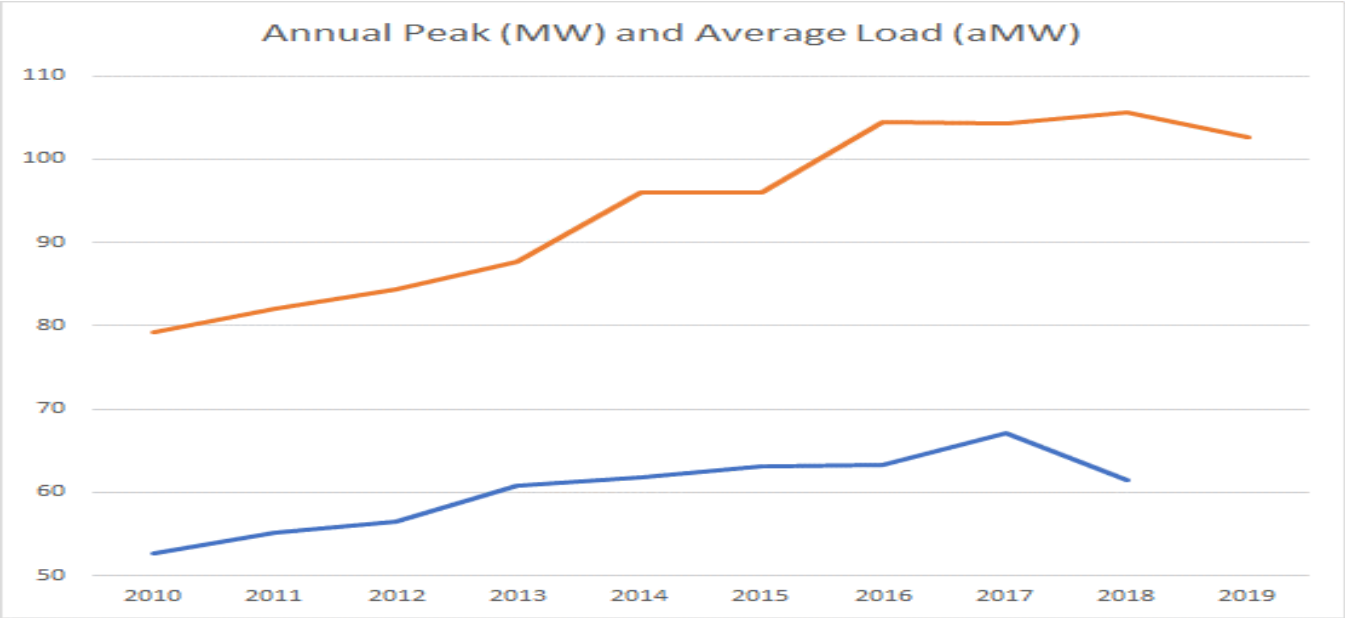


Figure 8: Annual Peak and Average Load in Electricity Demand

The review also indicated the lack of local information and policies on energy efficiency (EE) within the system as there is no legislation in Belize on the topic, and limited programs targeted at the subject matter. There is a legislation in the Caribbean on EE which the Belize Bureau of Standards plans to adopt shortly as Belize is a member of CARICOM Regional Organization for Standards and Quality (CROSQ) The government-owned Development Finance Corporation (DFC) was the only financial institution targeting EE for its lending, guided by the analyses of the consultant Econoler, which investigated renewable energy and distributed generation as well. EE could be a short-term source of relief for both the grid and the costs to end consumers. Even though excess supply is not keeping the costs elevated, the investigations did reveal that the demand on the network was not well managed mainly due to the lack of an energy-efficiency framework and the presence of inefficient products in the market and practices in the system. The Belize Bureau of Standards (BBS) is presently piloting a voluntary energy efficiency scheme with refrigerators where Unicomer and the Energy Unit are partners. BBS is responsible for the regulation and enforcement of standards, including appliances. However, the BBS also has capacity limitations in terms of financing and sufficient personnel to conduct compliance assessments. Belize is a member of the CARICOM Regional Organization for Standards and Quality (CROSQ). The recent energy efficiency labelling scheme pilot program aims to assist with the introduction of quality measures in the energy sector, in this case, through the introduction of EE standards to govern the minimum energy performance of refrigerators, air conditioners and lighting.

Despite there being enough energy supplied to the Belizean economy (see Table 4 and Figure 9), domestic generation has fluctuated over the past decade with the country mostly relying on imports for 44.4% of its electricity needs between 2012 and 2021. This leaves the sector open to price fluctuations in the Mexican economy and can have an impact on energy security as well, especially with the imports satisfying most of the consumer demand during its peak usage periods.

Table 4: Electricity Consumption vs Generation in the Belizean Economy

Consumption (kWh)										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SOCIAL		3,508,187	3,302,031	3,243,683	3,035,538	3,336,108	3,626,576	3,853,001	3,756,553	3,813,111
RESIDENTIAL	250,883,593	155,825,273	161,407,451	178,211,376	196,807,696	205,844,115	215,362,664	235,338,668	241,508,792	248,279,180
COMMERCIAL I		81,565,815	83,791,081	87,788,787	90,216,820	91,854,734	92,744,053	94,996,525	77,906,007	87,350,300
COMMERCIAL II	148,906,754	173,779,947	178,394,756	187,197,064	191,675,362	194,809,097	196,968,439	210,649,159	171,942,366	177,682,756
INDUSTRIAL II	37,597,181	43,698,510	42,380,747	50,551,601	32,567,382	30,466,150	20,835,912	19,527,474	19,511,220	18,741,571
STREETLIGHT	24,781,203	25,516,352	26,115,977	26,237,909	26,618,585	26,167,883	24,895,928	23,986,498	24,644,509	24,926,174
Total	462,168,731	483,894,084	495,392,043	533,230,420	540,921,383	552,478,087	554,433,572	588,351,325	539,269,447	560,793,092
Electricity Generation	528,172,490	550,952,578	566,180,628	605,519,382	614,662,588	630,158,991	631,092,753	669,184,812	613,681,079	646,033,588
Surplus/(Shortfall)	**66,003,759**	**67,058,494**	**70,788,585**	**72,288,962**	**73,741,205**	**77,680,904**	**76,659,181**	**80,833,487**	**74,411,632**	**85,240,496**

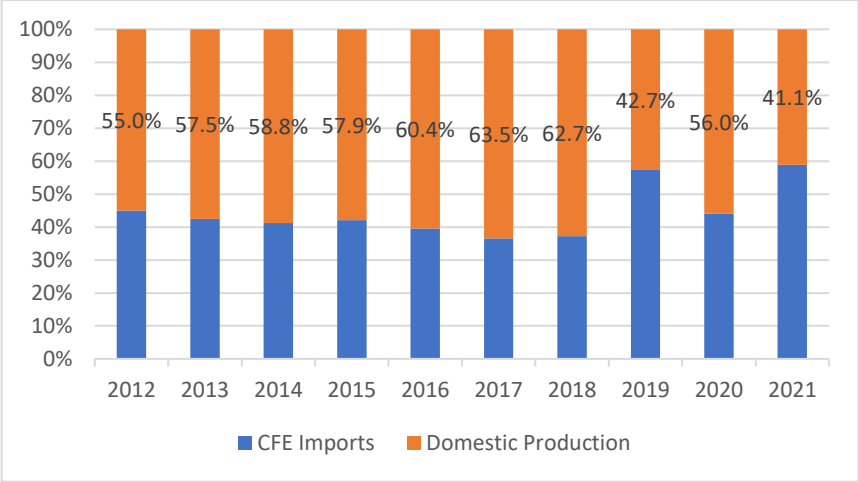


Figure 3: ***CFE Imports versus Domestic Production***

Data has indicated that there has not been a new IPP in the country since Santander in 2017, a business that successfully took part in the 2014 RFP process, along with another applicant that was to produce a 10MW solar power plant. The latter, although being approved through the RFP, has not finalized its PPA with BEL and as such has not commenced any type of operations for the new plant. Oversight authorities and suppliers disagree as to why this has happened, but the major issue is that there has been no significant investment in local generation for more than half a decade. As a result of stakeholder engagement, businesses have expressed interest in the market. Stakeholder engagement has indicated that there is no shortage of interest within the market, as businesses have inquired about the possibility. As stated before since 2014 there has not been an official RFP nor additional IPPs on the market, even though there are improvements in technology, which if tendered successfully could serve to lower costs in the Belizean market (see Figure 10). The PUC has stated that BEL has too much power in the procurement of new IPPs, while the latter has mentioned that there is a lack of capacity within the former to properly evaluate and bring the process to a close. This has resulted in a standoff in the procurement of new sources of energy into the system, leaving the network stagnant. Therefore, the enacting of the RFP draft legislation is paramount.

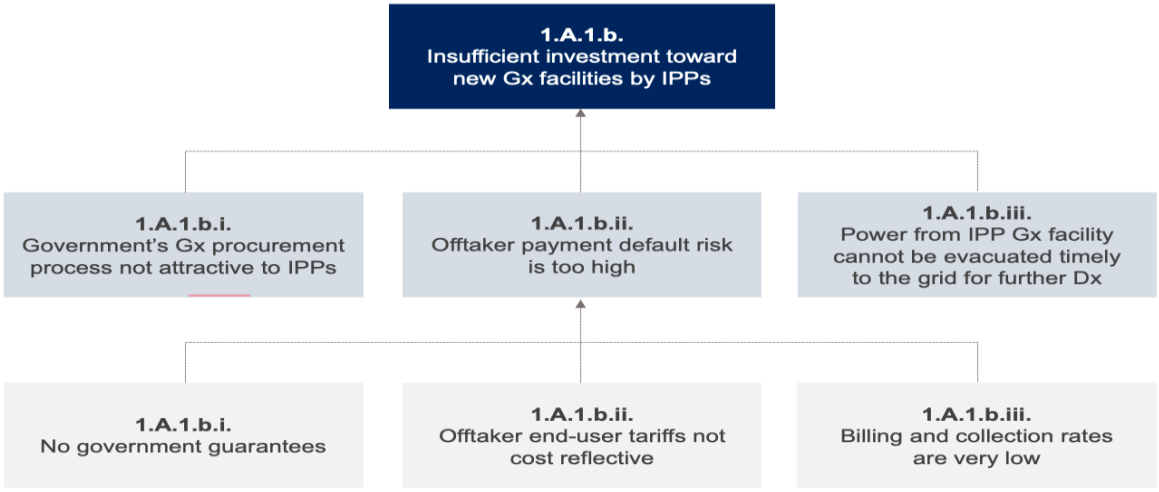


Figure 10: Insufficient Investment in Generation Facilities Root Cause

Inadequate Transmission and Distribution Network Capacity:

The transmission and distribution capacity of the network was reviewed, with part of the discussion associated with the overall demand and supply dynamics (Figure 11). The power line from Mexico has been a concern for the oversight authorities (PUC and Energy Unit), even though the supplier has kept it operating well below its maximum capacity (55MW). Projections are indicating that this singular transmission line from Xul-Ha, in Quintana Roo, Mexico would have to be operated without any redundancy, as the country's peak demand increases resulting in extra cost to BEL and by extension to the Belizean public. This extra cost is associated with the charges involved in keeping the line active with CFE, which includes a cost for congestion (PUC, 2022). The oversight agencies have indicated that the transmission and distribution losses on BEL's network are above 6%, while the benchmark for an efficient and adequate operation, that is, a well-performing system is at approximately 5%. If the network topology is improved, including an additional and larger transmission line from Mexico, it is estimated that these losses can fall below 4%.

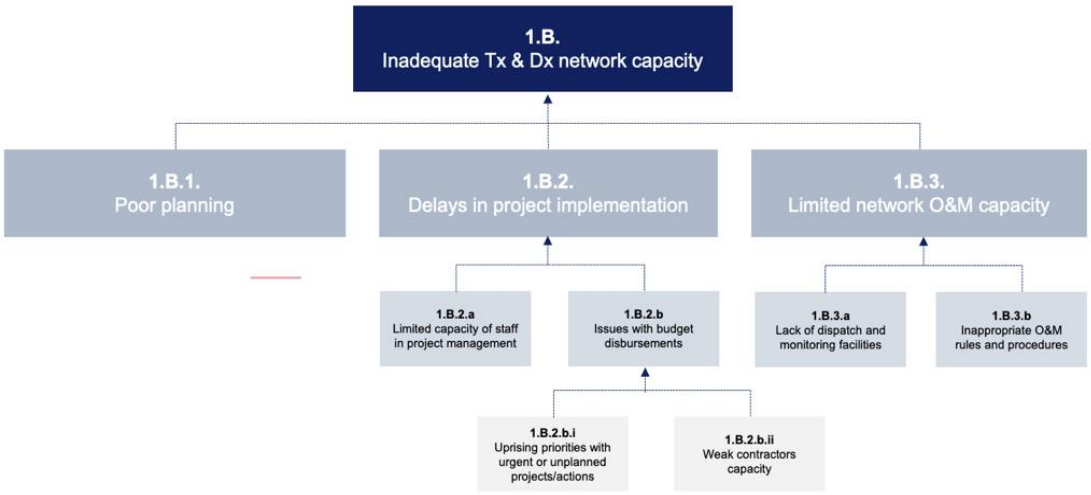


Figure 11: Inadequate Transmission and Distribution Network Capacity Root Cause

As a result of stakeholder consultations, concerns were raised regarding the administration of the system, where in one instance in 2022 it was cited that the supplier dispatched the most expensive option instead of failing to dispatch one of the most cost-effective options. As one industry participant points out, "We may create inefficient wholesale markets without clear dispatch rules based on merit ordering, especially during the wet season" (Tillet, 2021). The interviewees didn't explicitly state whether this was a recurring issue, though the oversight offices claimed it was a symptom of a larger problem with the system and the supplier wrote it off as a mistake made due a lack of a proper system of operations. Additional issues have risen as it pertains to the future structure of the system, and its execution, with the plan usually set by the Energy Unit and executed by the PUC and BEL. The latter two seem to be in conflict over some or parts of the expansion plans or the commission's recommendations for how the industry should operate. This results once again in a stalemate, limiting improvements and modernization on the grid.

High Cost of Power to On-Grid Customers

The PUC calculates Belize's electricity tariffs using a formula that incorporates the supplier's costs and return rate divided by projected sales to come up with a per kWh cost. As part of the initial rate proposal, BEL calculates the rate which is then vetted by the PUC, which in turn adjusts it when necessary to either penalize or award the distributor based on their analysis. The mean effective rate (MER), or the tariff being charged to the public, is set every four years and reviewed in an Annual Review Proceeding (ARP) in which the PUC gives its evaluation on the direction in which the tariff should be adjusted. The BEL, based on their own evidence, is given the opportunity to accept or reject the reviewed tariff overseer's judgments. By scaling up the tariff, if the PUC finds the rate should have been adjusted upwards based on the costs incurred by the distributor in the past, they are reimbursed. In the alternative, they are penalized by lowering their tariffs. In calculating the MER, the PUC considers BEL's operating expenses, an acceptable return, and the reference cost of power among other considerations. All the company's projected costs are weighed against the forecasted demand and as such a rate is set, which implies that BEL has a ***cost-reflective tariff***. BEL expected a higher return rate and more depreciation to be compensated

for than PUC in the 2021 ARP, but only marginally higher in their estimate of power costs. PUC ruled, however, that BEL did not provide enough evidence to support its claims in terms of the components that required higher compensation, so the approved tariff rate remained lower than what BEL requested. (See Figure 12)

	Extracted BEL submission			PUC calculations of MER			BEL-PUC
	2022|2023	2023|2024	Total	2022|2023	2023|2024	Total	
Value Added of Delivery (VAD)							
OPEX	33,506,842	34,008,830	67,515,672	33,506,842	34,008,830	67,515,673	(1)
Return	42,430,592	46,901,650	89,332,241	35,521,946	38,458,017	73,979,962	15,352,279
Depreciation	25,219,155	27,317,604	52,536,760	19,422,283	19,850,499	39,272,782	13,263,978
Taxes/Licence Fees	5,614,558	6,015,890	11,630,448	6,639,187	6,632,835	13,272,022	(1,641,574)
Sub-Total (VAD)	106,771,147	114,243,974	221,015,121	95,090,258	98,950,181	194,040,439	26,974,682
Reference Cost of Power (COP)	143,465,965	149,293,913	292,759,878	147,538,475	143,447,558	290,986,034	1,773,844
Corrections - FTRP	8,842,163	8,842,163	17,684,326	8,842,163	8,842,163	17,684,326	(0)
- ARP 21 + IE 2020	(338,486)	(338,486)	(676,972)	(338,486)	(338,486)	(676,971)	(1)
- ARP 22	(4,536,205)	-	(4,536,205)	(5,038,743)	(5,038,743)	(10,077,485)	5,541,280
- ARP 23							
Less: Other Revenue (OR)	4,668,673	4,668,673	9,337,347	4,668,673	4,668,673	9,337,347	-
Tariff Basket Revenue (TBR)	249,535,910	267,372,890	516,908,800	241,424,995	241,194,001	482,618,996	34,289,804
Demand [KWhs]	603,095,764	634,313,654	1,237,409,418	603,095,764	634,313,654	1,237,409,418	-
MER	0.4138	0.4215	0.4177	0.4003	0.3802	0.3900	

Figure 12: BEL vs PUC's Calculation of the MER for 2021 ARP

The tariff paid by the public is mostly due to the reference cost of power (60%), which is the cost that the distributor pays to the individual IPPs. Therefore, the remaining costs, including transmission, distribution, and administrative costs, as well as the rate of return for the service, amount to around 40% of the tariff. Various categories of consumers pay different tariffs based on consultation with the Government of the day. These customer categories are selected at the time the individual/business applies for a connection from BEL and is adjusted based on their usage. According to Figure 13, the tariffs paid by the company's customers are fair and adequate representations of their costs. However, a more detailed analysis needs to be done to determine if the reference costs of power are adequate based on benchmarks.

Average Prices *	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SOCIAL			0.41	0.36	0.31	0.30	0.30	0.32	0.35	0.35	0.34
RESIDENTIAL	0.44	0.42	0.48	0.44	0.38	0.36	0.36	0.38	0.41	0.41	0.39
COMMERCIAL I			0.50	0.46	0.40	0.37	0.38	0.39	0.43	0.43	0.42
COMMERCIAL II	0.44	0.41	0.48	0.46	0.40	0.37	0.38	0.40	0.43	0.44	0.42
INDUSTRIAL II	0.41	0.37	0.40	0.38	0.33	0.33	0.34	0.36	0.37	0.40	0.40
STREETLIGHT	0.55	0.55	0.55	0.51	0.44	0.41	0.42	0.43	0.47	0.47	0.45
All Classes	**0.45**	**0.42**	**0.48**	**0.45**	**0.39**	**0.36**	**0.38**	**0.39**	**0.42**	**0.42**	**0.41**

Figure 13: BEL Tariffs by Customer Classification

<u>High Generation Costs Incurred by Utility:</u>

Over the past five years (see Table 5), Fortis hydroelectric producers (BZ$0.25 per kWh) have been the most expensive power source for BEL followed by BELCOGEN (BZ$0.22), and then CFE (BZ$0.20). These costs were negotiated with BEL at the point where the relevant IPPs became active within the market and will remain in effect until their negotiated contract duration

comes to an end. All these sources have specific components of their PPAs/agreements that make their costs extraordinary when compared to the rest of the domestic market. At the end of 2021, the Fortis hydroelectricity sources (BZ$0.28) were twice the cost of the other hydro producer in the market, Hydro-Maya (BZ$0.14), and although there were differences in scale and investments the discrepancy was significant. By examining the Fortis PPAs, it was discovered that additional costs involved capacity payments, spill-clauses, and escalation costs, the latter implying an annual increase in the tariff regardless of efficiency

Table 5: Average Cost per KWH for Active IPPs in Market

COST PER kWh	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
BECOL - Mollejon & Chalillo	0.22	0.20	0.20	0.20	0.20	0.19	0.21	0.25	0.22	0.27
BECOL - Vaca Energy	0.21	0.23	0.22	0.23	0.22	0.22	0.23	0.39	0.24	0.28
CFE	0.37	0.31	0.19	0.17	0.13	0.20	0.27	0.26	0.12	0.15
Hydro Maya	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
BELCO GEN	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22
BAPCO L	0.55	3.08	2.36	0.73	0.46	0.54	0.48	0.37	0.92	0.45
Santander						0.18	0.17	0.17	0.15	0.15
JICA					-	-	0.07	0.00	0.15	0.05

In 2021, BELCOGEN IPP (BZ$0.22) received a higher rate of payment than Santander (BZ$0.15). Although there were differences in the production capacity and investment required for both facilities, the price differential was once again significant. There have been two increases in the price per kWh for BELCOGEN, but there are no annual escalation clauses. The price per kWh has increased for BELCOGEN on two occasions, although there are no annual escalation clauses present. In the case of CFE, pricing is done on the spot market and the company has varied from being the most expensive source of power to the country in some years (2012), to the least in others (2020). The variability in spot prices on the Mexican market makes the domestic investment,

particularly in energy-intensive industries very difficult to gauge and has an impact on investor confidence in the market.

The analysis of the system and the root causes of the elevated cost of power in the Belizean electricity market has led to several conclusions and are summarized in Figure 14 below. The most significant reason for the domestic tariff being above the rate in Latin America and the Caribbean is the fact that the PPAs negotiated with the existing IPPs were done at a significant benefit to some electricity producers. Furthermore, the system's operations are not modernized and efficient including end-user operations, which do not allow proper use of resources and keeps costs above normal. Lastly, there has been difficulty in acquiring new, lower cost power producers in Belize, also keeping wholesale electricity costs at a level that negatively impacts investment, consumption, production, and economic growth.

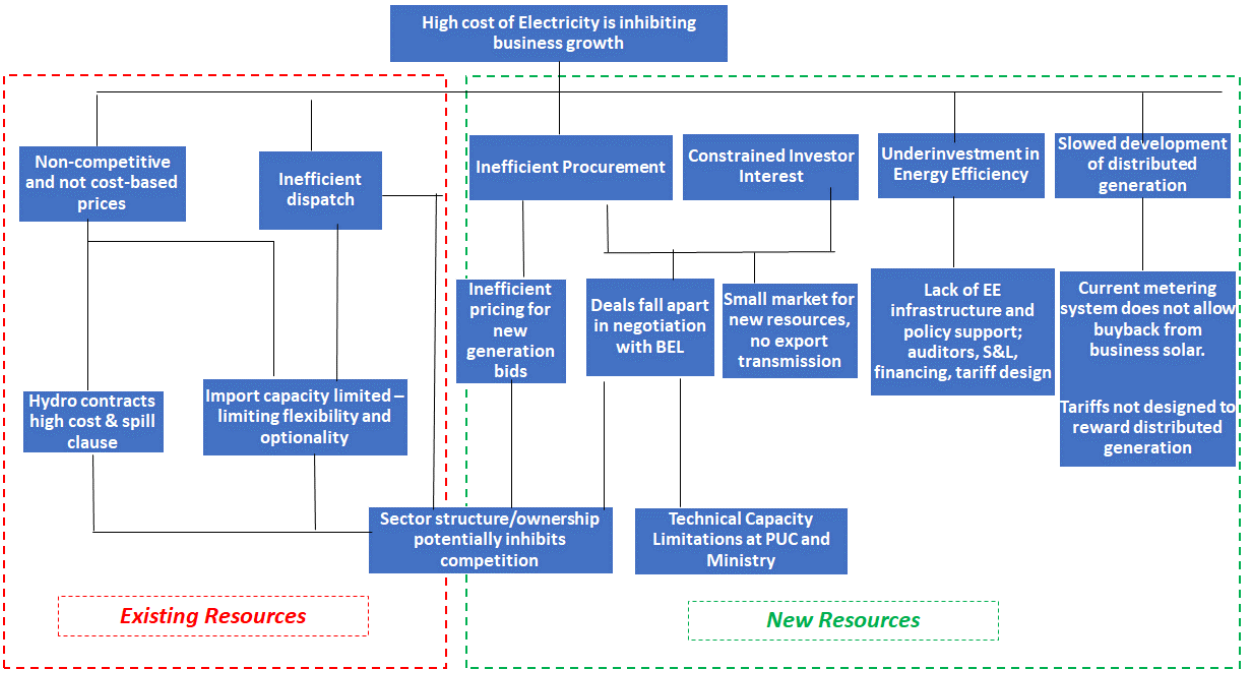


Figure 4: Cost of Power Root Cause Problem Tree

Summary of the Root Causes

The high wholesale electricity costs are due mostly to the limitations in the oversight, planning, and enforcement capabilities of governmental authorities which have limited resources and human capacity. As a result of these factors, legacy contracts have been poorly negotiated, sector planning and oversight has been inadequate, and new IPPs have been underutilized. As part of the process of acquiring the appropriate technology and capacity, the energy sector also needs a knowledge capacity building program. In order to take advantage of the appropriate technological adaptations and create a market that promotes competition in electricity distribution, the energy sector needs to develop the necessary knowledge capacity. This combined with the planning and enforcement capabilities of the oversight institutions will help to structure and modernize the grid to accommodate the changes in demand, as well as technological shifts in electricity production, as these subpar systems lead to further inefficiencies, which contribute to the elevated costs of electricity for all consumers.

Noncompetitive Legacy Contracts

The PUC stated that "rates charged by IPPs are not solely based on power production costs," which has led to some high costs for BEL as a result of various PPAs. Although PPAs were negotiated without any overarching harmonizing principle, integration with Mexico requires a greater convergence of market operating rules. Existing PPAs include "hard-coded" elements of market operations. For instance, PPAs for the Fortis hydro dams, which have included capacity payments, spillage clauses, and escalation clauses, are the ones incurring the highest costs during 2021. The hydro dam with Fortis has power purchase agreements (PPAs) that will expire in the 2050s. Below is a summary of these hydroelectric contracts, explaining how tariffs have increased. A summary breakdown of the PPA for these hydroelectric contracts, explaining how the tariffs have increased is given below.

For the Mollejon and Chalillo Dams, notable pricing clauses include:
Original Project Energy Price Per kWh

a. Less than or equal to 100,000,000 kWh: US $0.0875
b. For energy exceeding 100,000,000 kWh: US $0.05

Provided that:

c. the price per kWh specified in item (a) above shall increase by 1.5% per annum on the 1st of April each year beginning as of and including April 1, 2001, until and including April 1, 2036, such increase to be calculated on the price applicable as at the 31st of March immediately prior thereto; and
d. for certainty, effective as of April 1, 2001, no amounts shall become payable pursuant to Section 3.1 of the Original Power Purchase Agreement.

Based on the escalation clauses alone, the cost for Mollejon and Chalillo hydroelectric dams should increase from US $0.0875 in 2001, to US $0.1178 in 2021, and to US $0.1473 by the end of 2036. Additionally, the Vaca dam has been paid annual capacity payments of around $5.0mn since 2016. The initial agreement made for the Mollejon hydroelectric dam commenced on April 10, 1991, and was scheduled to continue until March 31 2051, with the end date being used for the contractual negotiations for the two additional dams as well. The dollar value that BEL pays for

this energy source has been around 32.7% of their total energy costs over the past ten years, so any rise per kWh will result in significant increases to consumers.

Inadequate Governance Capacity for Energy Planning and Oversight

The Energy Unit and the PUC are the oversight structure for the energy sector, but both are understaffed and additional technical staff need to be hired and trained to ensure that both their mandates are carried out effectively. Their technical expertise is lacking in some areas. PUC representatives noted that the adhoc way the industry was functioning had also created inefficiencies. As of 2008, the perception is that PUC delegated to the BEL the responsibility of "promoting competition in generation". This oversight structure is responsible for:

Energy Unit:

- Integrated resource planning; load forecasting, resource expansion, risk analysis
    - Renewable resource integration; modernized Grid Code, VRE forecasting, Grid integration
    - Energy efficiency planning and implementation; produce an updated EE cost curve as input for sketching out EE programs. Creating an enabling environment that strongly incentivizes investment in energy-efficient technologies and measures. (Roadmap)
    -

Public Utility Commission:

- Enforcement of adherence to policy in resource expansion
- Tariff for Distributed Generation and energy efficiency facilitation
- Tariff oversight

Policy, planning, procurement, and oversight capabilities within government agencies are limited, along with technical capacity gaps at all levels, which contribute to several governance issues that may lead to ineffective performance. The Energy Unit is currently drafting the country's most recent energy policy strategy, which hasn't been updated since 2011. Currently, the Unit is drafting a draft energy policy with the technical expertise procured internationally by the European Union and planning the requisite resource adequacy. As a result of limited financial resources, deficiencies in the supervisory structure, and a lack of legislative authority, the ministry is unable to implement a properly integrated resource planning process and take other important operational decisions. In addition, there is no local energy efficiency plan or legislation and, although DFC/Econoler have made some strides in raising awareness of energy efficiency and renewable energy among MSMEs, much more needs to be done to communicate EE/RE benefits and create a change in consumer choices, so that its potential usefulness in the Belizean economy can be realized. By 2023, the Belize Bureau of Standards plans to adopt three of Cross Q's EE standards (refrigeration, air conditioning, and lighting). The Belize Bureau of Standards plans to adopt Cross Q standards for solar equipment, ensuring quality in products entering the country. To make the importation of energy-efficient equipment mandatory, the Belize Bureau of Standards plans to pass a Statutory Instrument under the Standards Act in 2025. A regional EE Building Code can also be adapted for Belize.

The least-cost expansion plan for energy has been left to the supplier, BEL, a function traditionally performed by oversight agencies. Aside from expanding, modernizing, and improving the country's electrical grid, no new IPPs have been procured. In Belize, there are few AMI meters. By adopting these meters and associated accessories, BEL will be able to log and track energy consumption data and provide a more dynamic tariff regime. The PUC has prepared a White Paper that outlines the RFP process in the economy, but government approval and passage have been delayed. Moreover, Fortis is involved in both private generation and system operations as a 33.3% owner and member of BEL's board of representatives, creating a perceived structural conflict of interest. Since Fortis was the beneficiary in this instance, the operational issue in which dispatch failed to utilize the least expensive source of electricity is presumed to have arisen from this relationship. Furthermore, the supplier, BEL, has a portion of its board of directors appointed by the government, which brings a political risk.

Inadequate Transmission Capacity and Grid Resilience

Currently, Belize lacks sufficient transmission capacity to plan future domestic generation growth with intermittent renewable energy that has lower prices (see Figure 15). The maximum transfer capacity of the 115 KV transmission line connecting the two national systems limits the supply from CFE to 60 MW. Currently, BEL is unable to take more than 50 MW of power from Mexico without experiencing voltage regulation problems at certain load center bus bars. CFE has indicated that it is capable of supplying up to 60 MW under certain conditions. This could potentially lead to savings of over $3,000,000 USD per year, as Belize will be able to take more "economic" or "opportunity cost" energy at times when it is cheaper (Mencias and Esquivel, 2008). These operational issues created heightened administrative costs for the distributor, which is included in the tariffs being charged to consumers as well. An additional transmission line from the Xul-Ha, Quintana Roo node in Mexico would help alleviate the limitations cited above, however, a second line to a different interconnection station (Xpujil, Tabasco) could yield additional savings, efficiency, and resilience. Additionally, it opens the possibility to invest in larger power production facilities in Belize, which could affect the per-unit price of installed capacity.

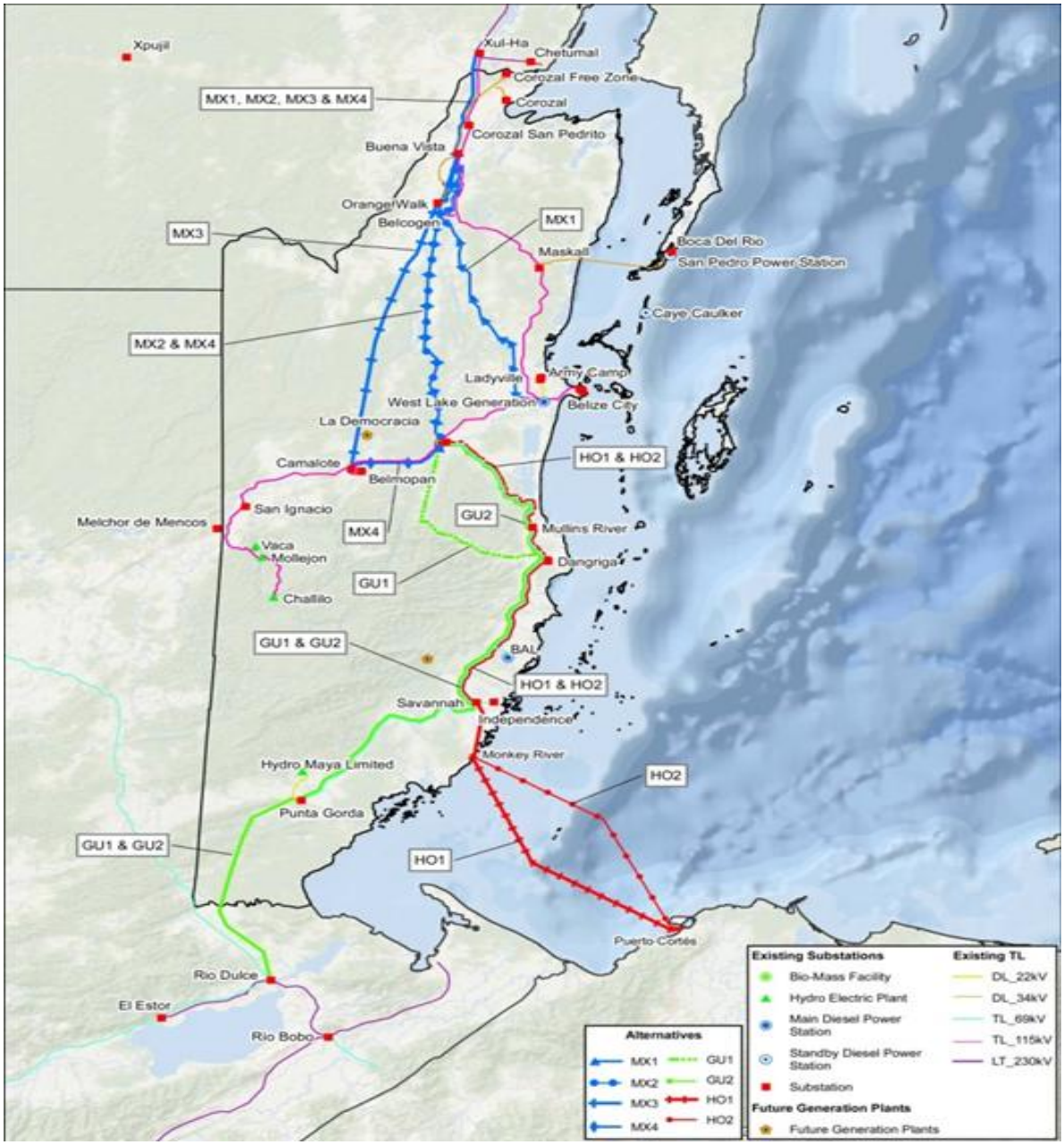


Figure 5: Belize's Current Transmission and Distribution Network

The expected benefits to Belize of strengthening the interconnection with Mexico or having a new interconnection with Guatemala (MER)[3] are manifold:

- increased reliability and stability of the Belizean power system
- improved security of electricity supply for Belize in the long term
- access to a larger market for both electricity imports and surplus energy exports

[3] Guatemala is said to have withdrawn from Central American Electrical Interconnection System (Sistema de Interconexión Eléctrica de los Países de América Central (SIEPAC)) (See Appendix VI).

- potential economic benefits to the power customers due to cheaper sources of electricity in Mexico and Central America. (Inter-American Development Bank, 2017)

In addition

- facilitate solar development with transfer capability
- increase market for investors; rapid load growth in Yucatan, allow Belize to tap land intensive resource for export

There are infrastructure developments in Mexico that may impact the price.

Challenges in Acquiring Low-Cost Resources

Relegating this function to the distributor, rather than to the sector's oversight body, has hampered the process of bringing new, cost-competitive IPPs online. One segment of the Belizean Electricity Market operates through competition in the market modality, such as operations in the Mexican Electric Market and domestic thermal generation. The new resource procurement and PPA negotiation is outlined as follows:

Under the Single Buyer business model, the following roles and responsibilities are applicable for the business functions conducted within the Utility Sector:

- Planning - Future supply capacity is administratively determined by the Energy Unit and PUC. Wherein the Single Buyer files the least cost, least risk expansion plan with demand forecasts, supply options, and recommended scenarios with them. This option effectively limits the participation of the oversight agencies. To ensure alignment with the interests of ratepayers these proceedings shall be conducted utilizing public hearings.

- Tendering - for new capacity for utility services is done through competition among private sector participants. The Regulator conducts a Request for Proposals (RFP) for the required capacity determined in the Planning Process. The Regulator then requires the Single Buyer to sign Utility Purchase Agreements (UPAs) with successful private sector participants. This is often described as competition for the market, in contrast to competition in the market.

The lack of human and financial resources of these agencies, and the ad-hoc manner of industry operations create inefficient ecosystems with little alignment with national interests. The distributor has not been able to finalize an IPP selected at the last competitive RFP in 2014, despite it being a renewable source, in line with government policies. Additionally, no significant headway has been made in the development of a timely plan to commence distributed generation domestically and in the construction of an additional transmission line from Mexico. The latter could provide reliability benefits as well as increase Belize's climate resiliency during hurricanes and climatic vulnerabilities such as flooding and increased fire occurrences. The former would contribute to the renewable energy targets of the country, reduce the reliance on imports and reduce the foreign exchange constraints, and provide an additional income source to the Belizean public. Adding distributed generation and other IPPs to the energy mix would require other improvements like grid and system flexibility, intermittency forecasting, and the accompanying improvement in the technical expertise of the oversight agencies and BEL.

Gender and Social Inclusion Considerations

The supply of reliable-affordable electricity is essential to the sustainability of economic growth and social well-being. There are challenges associated with local/institutional capacity skill sets, non-cost-reflective tariffs, and elevated levels of technical and commercial losses in the energy distribution chain that hinder Belize's ability to attract investments so that new energy suppliers and infrastructure systems can be sustained. Based on stakeholder interviews, the poor in particular have difficulties accessing power in Belize, with the MCC Constraint Analysis (2022) indicating that "close to 40% of poor households do not have access to power". Aside from the high cost of connecting to an electrical grid (30% of the general poverty line) and the high cost of power afterward, poor households that do have access to power also have to pay significant amounts to get it. Only 40% of indigenous households have electricity, compared to 82% of non-indigenous households. While there was no significant disparity between urban and rural areas (access rates of 97% and 87% respectively), there were disparities along regional lines, with Toledo experiencing the lowest access rate (29%), likely due to last-mile challenges and a lack of feasible off-grid solutions.

There is a growing body of evidence that supports the integration of gender and social responsive interventions in the energy sector yielding results not only good for stimulating economic activity, but great for advocating for meaningful sector reform and sound energy sector governance. In order to ensure long-term viability and sustainability of inclusive growth in Belize, the interests of women and other socially excluded persons must be considered. Within the energy sector, a Gender and Social Inclusion Capacity Assessment is needed to assess individual, local, and institutional capacity-building needs. It is essential to conduct further research on how high electricity costs affect the poor, including calculating the percentage of a poor household's income that goes towards electricity, EE penetration in households, and how electricity costs affect MSMEs, which are usually run by poor people. The high cost of power to consumers is likely to affect other development outcomes such as nutrition, healthcare, and education. Furthermore, research needs to be conducted on the effectiveness of the social tariff in reducing electricity costs, along with an evaluation of how the different customer classifications are created to see how the tariff impacts the poor.

Impact on Private Investment

Belize's economy is dominated by MSMEs, generating over 70% of private-sector employment and incomes and contributing significantly to GDP (IDB, 2014). In most cases, small, medium, and large enterprises reported that high electricity costs are hindering their growth. The growth of a medium-sized BPO company is tied to growth in electricity, and this company is looking into expanding into an industrial park arrangement. In the interviews (Protel BPO, CPBL, Citrus Growers Association, Marie Sharp etc.), large enterprises expressed interest in moving to solar generation or integrating solar as another source of electricity. Inquiries have been received from a large tourism company about installing solar panels, but no plans have been developed been

approved discussions have been tabled for over a year. According to the Citrus Growers Association (CGA), which represents 309 members, net metering/net billing is not yet available to local companies. In this system, CGA would receive electricity from BEL at night and use solar power during the day (currently they do not use solar power). Due to the lack of legislation for the private sector to buy back electricity from solar owners, BEL is not obligated to pay solar owners for the electricity they return to the grid. It is expensive to store batteries, and a net metering/net billing arrangement would enable CGA to have a solar farm that can help them with irrigation. In addition to exporting shrimp to Mexico, USA, and the Caribbean, Paradise Shrimp Farm also sells shrimp locally. Belize has an Export Processing Zone that the company is a member of. Paradise Shrimp Farm installed solar energy on their farm with a $1.25 million investment in capital equipment. They purchase electricity from BEL at night. Paradise Shrimp Farm pays BEL $30,000 to $40,000 a month in electricity even with this solar energy. For excess energy sold back to BEL, Paradise Shrimp Farm receives BZ$.13 per KW. In order to save on electricity costs, Paradise Shrimp Farm would like to receive a higher rate so that they can purchase updated, more efficient solar panels. Their electric bill is much higher than BZ $.13 per KW because they are paying BEL much more than BZ $.13 per KW.

Members of the Northern Fishermen Cooperative expressed interest in using solar power to power ice machines. Although there is liquidity in the financial sector, interest rates on loans remain high. Beltraide (a statutory body under the Ministry of Finance that represents thousands of companies and individuals in micro, small and medium sized businesses) asserts that more local energy production can drive down electricity costs and that renewable energy farms (such as solar farms) are feasible. The private sector senator who is also co-owner of a large BPO indicated an interest in setting up a solar farm separate from Protel BPO to connect to the grid and supply BEL with solar energy. Grace Kennedy Belize Ltd. (the third largest food importer/distributor in Belize) has been contemplating expanding into frozen produce and lowering electricity costs would assist them in making this a reality. The high electricity costs in Belize are not attractive for manufacturing firms and for firms interested in setting up manufacturing businesses in Belize, the high electricity costs present a barrier.

One suggestion regarding how the Government could best support the private sector is “to ensure that there is an adequate regulatory framework for private companies who would wish to supply services and products e.g., electricity, water, waste disposal etc.” (Potential Investments from the Private Sector for Climate Action in Belize, 2021). The Public Utilities Commission (PUC) (regulator) is moving to draft regulations which will give ordinary customers and businesses more authority over how they may want to connect with and interact with BEL because technology shifts are happening. The PUC expects that by the end of this decade that for industrial customers, hotels, major retail stores, and in certain parts of the country -such as in Northern Belize-, that a more cost effective and resilient way to meet the needs for electricity is for these customers to put in small solar installations in their home and business which are connected to BEL. This is called distributed energy resources (DER). Customers will be able to produce their own electricity and to trade with BEL. Therefore, BEL will not have absolute market power because of the DERs.

Public Private Partnerships

In October 2021, the Cabinet approved a draft Public Private Partnership (PPP) policy and the creation of a PPP Unit to mobilize private capital to fund large-scale infrastructure projects. Currently, this PPP Unit is being established. Refrigerators, air conditioners, and lighting are the main appliances that determine electricity consumption, according to the Belize Bureau of Standards, and energy efficient choices can save consumers money while also having a smaller negative impact on the environment. Approximately 24% of Belize's firms are hotels and restaurants (How can the private sector promote energy efficiency? IDB Invest, May 2022). Therefore, hotels can reduce their electricity costs by implementing energy-efficient air conditioning units. At ANCE, Mexico, the Belize Bureau of Standards, Unicomer, and the Energy Unit will learn about Mexican energy efficiency standards.

Information about the potential savings from energy efficient lighting contributes significantly to the diffusion of this technology among commercial entities. What can the private sector do to promote energy efficiency? IDB Invest, May 2022). The use of energy-efficient appliances will therefore require more information campaigns to educate individuals and businesses.

A possible solution would be to automate the energy audit process by collecting and processing data from smart meters and converting it into frequent, interpretable and actionable advice for firms. The receipt of audit information "cues" users to make changes that result in greater energy efficiency" (How can the private sector promote energy efficiency? IDB Invest, May 2022). It would be helpful for Belize to have some form of public-private partnership to make smart meters a reality.

Labeling appliances to promote energy efficiency is currently a voluntary program but is expected to become mandatory in the near future. Those standards will become national mandatory standards hopefully after the Belize Bureau of Standards establishes them. The pilot program will be carefully harmonised with other relevant standards and schemes, such as Mexican EE standards, Energy Star, etc. Efforts are being made by CARICOM and Belize to develop and harmonize energy efficiency standards. In addition, Belize is also working with OLADE under the "LATIN AMERICA AND THE CARIBBEAN ENERGY EFFICIENCY PROGRAM - PALCEE" - Integrated Utility Model.

Besides the lack of an energy efficiency law in Belize, the lack of public knowledge of available financing is another barrier. Development Finance Corporation (DFC) has been one of the few institutions working with the technical arm of the government to ensure that when they process sustainable energy loans, they ask about energy labels (for example, for buildings). A Caricom Regional Energy Efficiency Building Code can be implemented in Belize by the Belize Bureau of Standards.

Encourage Public-Private Investment

In order to promote smallholder participation in biofuel production, the government should encourage public-private partnerships value chains. This may be mandated by requiring that Smallholder participation in biofuel production should be encouraged as much as possible, and

public-private partnerships should be encouraged out of the electricity sector by 2050. Agricultural and forestry raw materials are used in the production of biofuels. It would be necessary for the government of Belize to upgrade research, characterize the subs (wood, agriculture residues) and begin to understand the technology. A commercial phase of biofuel production can then be initiated. Belize has tremendous forestry and agriculture resources which can make biofuel and the reality in 2022 it is easier from a technical standpoint to make gaseous biofuel than to make liquid biofuel.

According to Jeffrey Locke, former CEO of BEL, citrus waste should be studied as a biofuel in Belize. Electricity can be generated from this biofuel. It is hoped that Belize will invest in gaseous fuel between now and 2035. "Overall, we should continue to emphasize the importance of utilizing biofuels, especially since they are much more environmentally friendly and cheaper than fossil fuels" (Beltraide website).

The proposed interventions will improve the investment and competitiveness environment in the local electricity system, an area that is already attracting significant interest from both local and international players. By improving the RFP system to allow additional IPPs to enter the Belizean market, as well as improving their operations, domestic electricity production and ancillary services will be significantly expanded. Moreover, new opportunities could arise in the market due to the potential for new areas of operations and physical infrastructure.

V. APPENDICES

Appendix I: Chronology of Power Sector Developments in Belize

1991: A set of secret Agreements (*Franchise, Power Purchase and Guaranty Agreements*) to build a hydro facility on the Macal River is signed. After a series of negotiations, this eventually results in the creation of BECOL and the commissioning of the Mollejon hydroelectric power plant and associated 115 kV transmission line along the central corridor under a 2nd Master Agreement. Later in 1996 BECOL would commence operations at Mollejon and the transmission line is transferred to BEL for $1. Notably, recovery of the 115 kV transmission facility is contained in the cost of power, estimated as just under ¼ of the rate charged by Mollejon.

1992: The Electricity Act is passed creating a legal framework for a Regulator - the Office of Electricity Supply to foster participation of private actors in generation/supply, and the creation of BEL (private company) from BEB (state enterprise).
A minority stake in BEL is sold to the public, and a limitation of a maximum holding of 25% by a private investor is established.

1995: The Governments of Belize and Mexico sign a 12-year agreement for the sale of electricity from CFE to BEL. It becomes the basis for BEL to invest in an interconnection at 115kV from Westlake (Mile 8.5 on the George Price Highway) to Xul-Ha, Mexico and to undertake its largest transmission expansion connecting San Pedro, the northern region and Dangriga to the National Grid. A number of autonomous diesel power stations are decommissioned after power purchases at 115 kv start in December.

1996: Belize's first independent power producer (IPP), Belize Electric Company Limited (BECOL) commences operations of its Mollejon hydroelectric power plant (*contracted as 25.2 MW*).

1999: The Public Utilities Commission (PUC) is created and the Electricity Act is amended to grant the Commission jurisdiction over the Electricity Subsector, shifting from the Office of Electricity Regulation. A majority stake in BEL is sold to Fortis Inc. of Canada. The Articles are later amended *Ex-post* to allow majority ownership of BEL by a single private investor. Purchases from Mexico at 115 kV commences at yearend under a Firm capacity and associated energy contract.

2001: Fortis Inc. of Canada campaign to acquire BECOL from Duke Energy succeeds and the acquisition is approved by the PUC. At the same time, the Commission secretly approves the Mollejon 3rd Master Agreement that effectively clears a key regulatory hurdle for the construction of Chalillo. The PUC's Decision subsumes Chalillo under the Mollejon PPA, increased tariffs for Mollejon/Chalillo sales above 120 GWh from US$0.01/kWh to US$0.05/kWh and extends the PPA term from 2036 to 2055. Litigation follows that culminates in favour of the contracting parties.

2002|03: BEL files with the Commission a least cost expansion plan (LCEP) making the claim that construction and operation of a gas turbine is recommended. The Commission subsequently grants a Consent to BEL for the construction and operation of a *General Electric* LM2500 fired with #2 diesel sited at Westlake. The contractual terms approved by the Commission for BEL's investment have no standards of performance, but all costs reported by BEL is paid by ratepayers. The LM2500 commences operations in mid-2003. At the same time BEL issues a Request for Proposals (RFP) for 18 MW of baseload power. Hydro Maya and BelCoGen are selected.

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2005: BEL issues an RFP for 25 MW of baseload power. For the first time licence term for hydro is specified as 50 years, all other technologies are granted 15 year terms. Vaca is selected and BAL/BAPCOL is subsequently contracted. A dispute erupts between the Commission and BEL over the selection process. Litigation follows and the authority of the PUC in requiring the utility to sign PPA's it approves is upheld. BECOL commences operations of its upstream hydroelectric facility at Chalillo.

2007: Belize's second IPP, Hydro Maya Limited (HML) commences operations of its Rio Grande hydroelectric power plant (*contractual 3.4 MW*). CFE discontinues the Firm capacity and associated energy contract and therefore purchases from CFE by BEL can only continue under the Opportunity energy contract.

2008: In its 2008 Rate Review the Commission disallows $36.2 million in costs claimed by BEL. The largest component of the disallowance is the purported sale of the Mollejon transmission facility from BECOL to BEL for almost $30 million. The Fortis Inc. controlled BEL immediately takes the Commission to court and wins an injunction preventing retail rates being lowered. Further the Court granted leave for a judicial review of the Decision, BEL citing 12 grounds where the methodology employed by the Commission was arbitrary and capricious, and claimed the process applied was also unlawful.

2009: Belize's third IPP, Belize Co-Generation Energy Limited (BELCOGEN) commences operations of sugar cane cogeneration at BSI Sugar Mill Complex at Tower Hill in Orange Walk. BELGOGEN generates electricity burning bagasse utilizing a 12.5 MW backpressure steam turbine and a 15 MW condensing-extracting steam turbine. Under the PPA with BEL it nominally exports 13.5 MW into the Grid. In addition, there were 2 x 2.0 MW diesel units than can be fired with HFO, which were retired a couple years later. Belize's fourth IPP, Belize Aquaculture Limited (BAL) {later reassigned to Blair Athol Power Company (BAPCOL)} commenced operations of its HFO-fired, reciprocation internal combustion engine (RICE) power plant, sited north of Placencia.

2011: The Government of Belize acquires the majority shareholding in BEL held by Fortis Inc. after a long running dispute that started in 2008 between the utility and the PUC, resulting from that Rate Decision. Fortis Inc. loses its legal battle against the PUC, the court finding that none of the 13 grounds were valid. Thereafter Fortis Inc. demands that the Government amends the Law in accordance with Fortis' wishes.

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2012: Cabinet endorses a National Energy Policy (NEP) for Belize. Inline with the recommendations of the NEP, a new Ministry of Energy, Science & Technology, and Public Utilities (MESTPU) is created. The Ministry publishes its Strategy and Action Plan later that year. Operations of a .48 MW, solar demonstration facility at University of Belize commences. .

2013: Later in the year the PUC launches the RFPEG2013. The solicitation is for 60 MW of dispatchable resources and 15 MW of variable renewables.

2014: RFPs had two hydro bids - that did not come online (rights for Macal rover is owned by BECOL)
Santander in RFP. .

2015: The results of the RFPEG2013 are disseminated- Santander Sugar and BAPCOL's 3rd engine are selected and their facilities are subsequently brought into service. BAPCOL Solar remains in negotiations.
Southern Renewable Energy Limited and GSR Energy are unresolved.

2017: Belize's fifth IPP, SS Energy Limited (SSEL) commences operations at SS Sugar Mill Complex near Valley of Peace in Cayo District. SSEL generates electricity burning bagasse utilizing a 16 MW backpressure steam turbine. Under the PPA with BEL it nominally exports 8 MW into the Grid during the sugarcane processing season. BAPCOL's 3rd engine is subsumed under the original PPA. That is, the capacity under contract with BEL moved from 2 x 7.5 MW to 3 x 7.5 MW.

2018: Mexico had restructured its electricity industry in 2016 and implemented new Market Rules, including creating a Day Ahead market. However, these reforms did not materially impact BEL until 2018 when *CFE Calificados* became its broker.
The 15-year commercial agreement for the LM2500 expires and the Commission requests that BEL files for its review and approval a Repowering Plan; which the Utility has failed to do. In its Rate Review the Commission adjusted the compensation to BEL for the electricity services from the Mile 8 facility as 20% of the Return approved in its 2003 Decision.

2020: The PUC launched the gas-to-electricity RFP (GtE RFP2020). The solicitation is for 20 MW of baseload supplies fired with natural gas or some other hydrocarbon gas liquids + the

construction and operation of an associated terminal at Commerce Bight in Stann Creek District. The selected developer *SeaOne Holdings LLC* was determined by the Commission to be unable to deliver on its patented Compressed Gas Liquids solution, as per a Memorandum of Understating with the Government. This RFP was therefore not successful. .

Appendix II: Detailed Generation Supply Cost by Plant

Table 1: Belize Price Structure by Plant Power (US$/MW-month) -Energy (US $/MWh

COSTS POWER + ENERGY	dic-17	dic-20	dic-23	dic-26	dic-29	dic-32	dic-35
OIL&GAS BASE							
Existing Supplies + IPP							
GT							
Power (USD/MW-month)	12,918.8	6,459.4	6,459.4	6,459.4	6,459.4	6,459.4	6,459.4
Energy (USD/MWh)	200.0	299.8	329.7	354.8	368.9	398.8	409.3
BAL/BAPCOL							
Power (USD/MW-month)	23,817.6	23,817.6	23,817.6	23,817.6	23,817.6	23,817.6	23,817.6
Energy (USD/MWh)	115.0	181.5	210.2	238.3	260.9	286.9	299.6
CFE							
Power (USD/MW-month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Energy (USD/MWh)	89.5	112.6	108.6	110.4	112.7	113.4	111.6
BECOL (Chalillo)							
Power (USD/MW-month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy (USD/MWh) first 100 GWh/year	117.0	122.3	127.9	133.7	139.9	146.2	152.9
Energy (USD/MWh) over 100 GWh/year	52.5	52.5	52.5	52.5	52.5	52.5	52.5
BECOL (Mollejon)							
Power (USD/MW-month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy (USD/MWh) first 100 GWh/year	117.0	122.3	127.9	133.7	139.9	146.2	152.9
Energy (USD/MWh) over 100 GWh/year	52.5	52.5	52.5	52.5	52.5	52.5	52.5
BECOL (Vaca)							
Power (USD/MW-month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy (USD/MWh)	85.1	88.9	93.0	97.2	101.7	106.3	111.2
O&M (USD/month).	225,298.5	235,589.8	246,351.1	257,604.0	269,371.0	281,675.4	294,541.9
Hydro Maya							
Power (USD/MW-month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy (USD/MWh)	67.5	67.5	67.5	67.5	67.5	67.5	67.5
Belcogen							
Power (USD/MW-month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy (USD/MWh) bagasse	105.5	110.8	116.5	122.3	128.5	135.1	141.9
Energy (USD/MWh) fuel	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SSE							
Power (USD/MW-month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy (USD/MWh)	82.0	82.0	82.0	82.0	82.0	82.0	82.0

Appendix III: Ministry of Energy's Roadmap: Proposed Energy Interventions

Section	Activity	Responsible	Support
2	**Help Households, Business, and Government be More Efficient**		
2.1	Decentralize Government Payment for Electricity	Ministry of Finance	MTEPU
2.2	Adopt and Implement Standards & Labels for:	MTEPU, BoS	CBA, Consultant, Others
2.2.1	Appliances, in particular lighting, refrigeration, cooling & ventilation, etc.		
2.2.2	Buildings, in particular commercial and public use	CBA	
2.3	Develop Financial Mechanisms to Invest in Sustainable Energy		
2.3.1	Develop and Operationalize Financial Mechanism for the Public Sector	Ministry of Finance	MTEPU, Consultant, ESCO, DFC
2.3.2	Cabinet to Implement EE Procurement		
2.3.3	Develop and Operationalize Financial Mechanism for the Private Sector	MTEPU	MTEPU, Consultant, DFC
2.4	Provide Consumers More Information on Energy Services and Equipment		
2.4.1	Adopt Certifications for Energy Services	PUC, BoS	MTEPU, Consultant, AEE
2.4.2	Drive Energy Efficiency and Energy Management in Public Sector Operations	MTEPU, MoF	
2.4.3	Encourage adoption of Energy Management Best Practices in Private Sector	CBA, MTEPU	MTEPU, Consultant
3	**Expand Access to Electricity Using RE**		
3.1	Develop an electrification plan for energy poor communities	MTEPU	LGRDD, BEL
3.2	Develop an electrification investment program	MTEPU	LGRDD, BEL
4	**Promote Large Scale Renewable Energy**		
4.1	Regulator reviews, widely consults and approves LCEP filed by Utility	MTEPU	Clinton Foundation
4.2	Develop an appropriate Licensing Regime	PUC	Consultant
4.3	Streamline and Clarify RE Permitting Process	MFFESD	MTEPU, LUA
4.4	Accommodate the Integration of Intermittent RE into the Grid		
4.4.1	Conduct VRE Integration/Impact and Grid Modernization Studies	BEL	Consultant
4.4.2	Update the Grid Code	BEL	PUC, Consultant
4.5	Conduct Assessments of RE potential	MTEPU	Consultant
4.5.1	Small hydro		
4.5.2	Wind		
4.5.3	Solar		
4.5.4	Biomass, including waste-to-energy		
5	**Build an Efficient and Enabling Utility**		
5.1	Cost of Service Study review and approval by Regulator	BEL, PUC	Consultant
5.2	Amend the Tariff Structure		
5.2.1	for cost reflectivity of EE and Distributed Generation	PUC	Consultant
5.2.2	decouple Tariff Structure from electricity sales	PUC	Consultant
5.3	Re-orient BEL's incentives to meet EE and RE goals	PUC	Consultant
5.4	BEL to update its least-cost expansion plan (LCEP)	BEL	Consultant
5.5	BEL to deepen integration with regional power pools	MTEPU, BEL	Min. Foreign Affairs, Consultant
6	**Prepare for Distributed Generation**		
6.1	Develop appropriate Standard-Offer Contracts and Feed-in-Tariffs	PUC	Consultant
6.2	Adopt appropriateTechnical standards and connection procedures	PUC	Consultant
7	**Increase Awareness and Enhance Skills**		
7.1	Provide Training and Capacity Building		
7.1.1	Training for PUC staff in appropriate RE and EE skills	MTEPU w/ PUC, BEL	Consultant
7.1.2	Build the Capacity of the MTEPU	MTEPU	Consultant
7.1.3	Implement Technical Training Programs for EE and RE Technologies	MEYS	Consultant
7.1.4	Train Financial Institutions on Lending for Sustainable Energy Projects	MTEPU	Consultant
7.1.5	BEL to build capacity to Plan and Manage Intermittent RE	BEL	Consultant
7.2	Provide Education and Public Outreach		
7.2.1	Develop and Deliver relevant Curricula and Programs for Tertiary Education	MEYS, MTEPU	Min. For., Fish., Sust. Dev., Env.; UB
7.2.2	Develop and Conduct a Public Outreach Campaign	MTEPU	Consultant
7.2.3	Relevant STEM Curricula for Primary and Secondary Education	MEYS, MTEPU	Min. For., Fish., Sust. Dev., Env.

Legal / regulatory
Finance
Education / capacity building
Utility / technical

Appendix IV: Approved Retail Tariffs

Schedule 6

Belize Electricity Limited (BEL)
Approved Tariffs for Full Tariff Period (FTP) - January 1, 2021, to June 30, 2024

Customer Class	Service Type/ Consumption Block	Rate/Tariff $/Mth; $/KVA; $/KWhr
Social	0 - 60 KWhrs Minimum Charge	0.22 5.00
Residential	0 - 50 KWhrs 51 - 200 KWhrs > 200 KWhrs Minimum Charge	0.33 0.38 0.43 10.00
Commercial 1	0 - 50 KWhrs 51 - 200 KWhrs > 200 KWhrs Minimum Charge	0.33 0.38 0.43 10.00
Commercial 2	Service Charge 0-10,000 KWhrs 10,001-20,000 KWhrs > 20,000 KWhrs	150.00 0.41 0.39 0.38
Industrial 1	Service Charge Demand (KVA) Energy	250.00 35.82 0.30
Industrial 2	Service Charge Demand (KVA) Energy	250.00 23.00 0.26
Street Lights	Energy	0.45

Appendix V: The Electricity System of Mexico and Yucatan

Mexico's interconnected power grid is divided into seven control regions operated by the national system operator, CENACE. Campeche, Yucatán, and Quintana Roo conform to the Peninsular Regional Control Center (GCR PEN, in Spanish) within Mexico's Electricity Interconnected System (SIN). The GCR PEN has suffered from electricity supply issues since 2010, mainly due to operational limitations and low supply of gas to the region. Within Mexico, the Yucatan region has the highest prices. Due to natural gas supply scarcity and insufficient transmission capacity (which creates congestion) between the Peninsula and the rest of the country, electricity is expensive and unreliable; often local generators resort to expensive, polluting alternatives (e.g., fuel oil) or to natural gas when faced with shortages (National Renewable Energy Laboratory, 2021)

Ilustración 1. Variación anual (%) del PML diario y de la demanda diaria por GCR del SIN, 2018 a 2019

(ESTA International - Monitor Endependiente del Mercado Electrico, 2019)

Table 2. **Average Price (USD/MWh) and Changes by Region**
2016–2019

System	2016	% Change	2017	% Change	2018	% Change	2019
Central	46.84	44	67.34	26	85.15	–5	80.70
Noreste	44.10	32	58.34	18	69.09	–19	55.79
Noroeste	48.02	29	61.80	18	72.87	–37	45.65
Norte	46.36	43	66.22	25	82.98	–29	58.75
Occidental	47.54	42	67.47	26	84.70	–12	74.91
Oriental	46.58	43	66.52	26	83.68	–2	82.13
Peninsular	53.51	59	85.21	44	122.57	4	127.62

(NERA Economic Consulting, 2019)

Average electricity prices in the peninsula were the highest of the SIN and 39% higher than its neighbor ORI region. The main causes are low supply of natural gas that forces most of the

primarily fossil fuel generation fleet to use fuel oil and diesel, and system unavailability, transmission congestion, and a small percentage of renewable generation. (National Renewable Energy Laboratory, 2021)

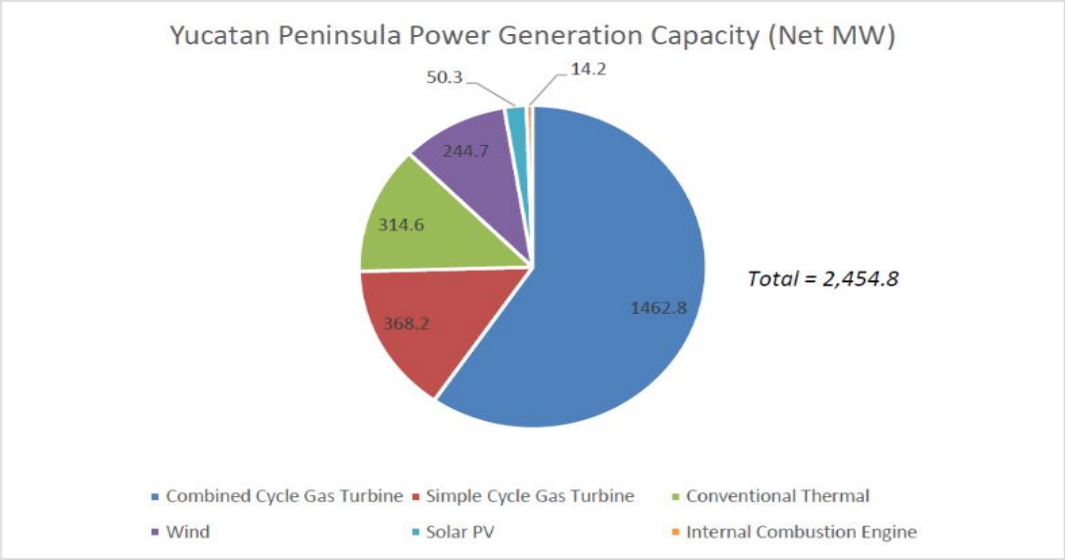

Figure 1. Power generation capacity by technology shows 78% fossil fuels and 12% variable renewable sources

Source: NREL with data from CENACE

Appendix VI: Central American Electrical Interconnection System (Sistema de Interconexión Eléctrica de los Países de América Central (SIEPAC))

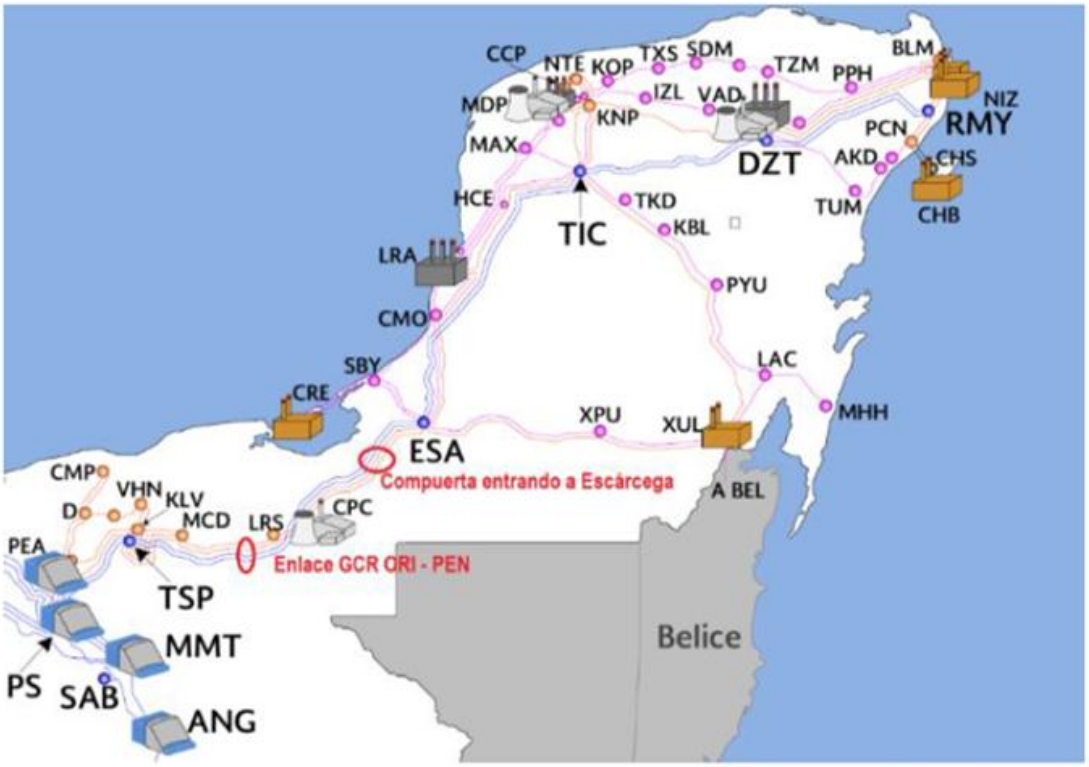

Figure 2: GCR PEN transmission and interconnection with the GCR ORI

Note: For the purposes of this graph, it is considered that the electrical substation SLC and the generator CPC are geographically at the same point

Source: MIM 2019

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