



USAID/HAITI Pilot Project for Sustainable Electricity Distribution (PPSELD)

Closeout Report

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List of Acronyms and Abbreviations

CCEP	Caracol Community Electrification Program
CIP	Caracol Industrial Park
EdH	Electricite d’Haiti
GIS	Geographic Information System
GOH	Government of Haiti
HTG	Haiti Gourde
IDB	InterAmerican Development Bank
kWh	Kilowatt-hours
LV	Low Voltage
MV	Medium Voltage
MW	Megawatts
MWh	Megawatt hours
NRECA	NRECA International
PPSELD	Pilot Project for Sustainable Electricity Distribution
USAID	United States Agency for International Development
USD	United States Dollars

Executive Summary

The Government of Haiti (GoH), with the support of USAID, is implementing a program to expand the electrification of Haiti. This program aims to attract private investment for the 10 regional departments, including the Project for Sustainable Electricity Distribution - PPSELD service area. In 2020, USAID and NRECA International (NRECA) signed a contract for the continued management and operation of the PPSELD utility. This contract period is called the Project for Sustainable Electricity Distribution - Transition, or PSELD-T.

The most significant event that affected the operations of PPSELD in the two years of project implementation was the COVID-19 pandemic. PSELD-T adopted and implemented social distancing and hygiene protocols issued by the health authorities, and other measures to ensure the safety of PPSELD clients and employees.

Despite COVID-19 restrictions, NRECA continued to comply with the technical, operational, commercial and customer service requirements to ensure efficient operation of the PPSELD utility. As a result, very high levels of service quality and reliability were achieved and maintained through PSELD-T project period. High levels of performance were maintained for quality of electricity service, collection rates as well as loss control

The PSELD-T project consisted of four tasks designed to ensure high levels of performance in preparation for the transfer of utility management from NRECA to a new, private operator. Task 1 was focused to provide reliable and efficient electricity service throughout the PPSELD utility service area. To achieve this objective, NRECA team members oversaw local PPSELD utility generation and distribution administrative, operational and commercial staff to ensure excellence in distribution system operation, billing and collections, loss management, and multiple customer service activities including connection of new consumers, disconnections, registration of complaints and addressing customer complaints in a timely fashion.

Task 2 focused on operation, repair, and maintenance of the generation plant. At the outset of the PSELD-T contract, NRECA was forced to take full, direct responsibility for the PPSELD powerplant due to the decision of the former sub-contractor not to participate in PSELD-T. NRECA retained most of the PPSELD personnel for PSELD-T, hired a new generation plant supervisor and directed all power plant operations, preventative and corrective maintenance, as well as staff training and performance monitoring for the generation plant. Throughout the PSELD-T project period, the PPSELD power plant remained the most reliable power plant in Haiti with an average service availability index (ASAI) of 99.66% for the year of 2020 and 99.75% for the year of 2021.

Task 3 focused on reduction of technical and non-technical losses. Due to the COVID-19 pandemic during this period of PSELD-T contract, the activities of the revenue protection crews were significantly restricted. However, disconnections of illegal connections and theft control remained a necessary and essential project activity. Through January 2022, 768 illegal connections were disconnected, and 182 cases of electricity theft were discovered. Electricity losses during the 24 months remained stable at an average of 11.5%. Losses within the CIP averaged around 5%, while losses outside the park were 15% to 16%.

Task 4 was defined as a support activity in which NRECA was required to facilitate the transition to management by a private operator. The GoH continued to implement its strategy to privatize the electricity service in the 10 departments of Haiti, including the PPSELD service area. To comply with this task, the NRECA team provided periodic to the USAID technical team including provision of data and information regarding PPSELD operations. Unfortunately, negotiations with leading candidates did move forward and the GoH decided to abandon negotiations in October 2021. A new tender process was expected in 2022.

Considering current economic and political conditions in the country and the Haitian electricity market, PSELD-T has achieved remarkable success. Overall revenue recovery allowed PPSELD to cover fuel, local labor, and other operating costs. Power reliability and availability continued on par with high-performing electric utilities in Latin America and the Caribbean. Due to the devaluation of the Haitian Gourde (HTG), the current tariffs do not provide for the total recovery of PPSELD operating costs. Going forward, tariffs rates should be indexed in a way to provide for full cost recovery and adjust to the fluctuations in the international fuel markets.

Project for Sustainable Electricity Distribution Transition (PSELD-T): Closeout Report

Introduction

USAID awarded NRECA International the contract to implement the Pilot Project for Sustainable Electricity Distribution (PPSELD) in May 2013. The PPSELD project was an initiative to establish a generation and distribution electricity utility in northeast Haiti to provide reliable and sustainable electric service. The primary task of PPSELD was to operate a 10MW HFO-diesel power plant located in the Caracol Industrial Park (CIP), to commercialize power within the CIP to industrial clients in the CIP, and to expand electricity service to residential and small commercial customers outside the CIP in several communes that are in the vicinity of the CIP, Caracol, Terrier Rouge, Trou du Nord, Limonade and Saint Suzanne.

The GoH with the support of USAID began a process to attract private investors to engage in concession agreements to operate electric power facilities in ten departments in Haiti. The PPSELD service area is included in this program. In recognition of this program, USAID designed a transition project that was awarded to NRECA as the legacy contractor to the PPSELD project. This transition project is called Project for Sustainable Electricity Distribution - Transition, PSELD-T.

The most significant event that affected the operations of PSELD-T in these two years was the COVID-19 pandemic that affected Haiti as it did all countries throughout the world. Although Haiti did not report infection rates as high as many other countries in Latin America and the Caribbean, restrictions taken to reduce the spread of COVID-19 significantly affected all PSELD-T activities. PSELD-T implemented the social distancing and hygiene protocols issued by the health authorities. For this purpose, PSELD-T implemented a policy for employee compliance.

Despite the restrictions, NRECA continued to comply with the technical, operational, commercial and customer service policies and procedures implemented for an efficient operation of the electric company. As a result, very high levels of service quality and reliability were maintained, high levels of collection. Despite the limitations to continue with all the inspection actions to control the theft of electricity in the users' homes and the impact on the users' economy, the level of losses was controlled and did not increase.

This scope of work for PSELD-T includes four main tasks that are summarized in Table 1 below.

Table 1 Description of the tasks to be implemented

Task Number	Task Summary Name
Task 1	Provide reliable and efficient electricity services
Task 2	Operate and maintain the 10 MW generation plant, distribution grid, and ancillary equipment.
Task 4	Facilitate transition to future private operator.
Task 3	Reduce non-technical electricity loss by increasing metered customers

This document presents the closeout report of the PSELD-T project. The report describes the tasks and activities undertaken by NRECA on behalf of USAID as well as the results achieved over the two years of project implementation. NRECA submitted monthly and semi-annual progress reports that summarized activity challenges and results throughout the PPSELD implementation period.

Task 1 Provide Reliable and Efficient Electricity Service

Commercial and customer service department

The activities of the commercial and customer service department were focused on billing and collection, connections and disconnections, and attention to customer needs and concerns. The commercial/customer service team members were responsible for all facets of customer service, meter reading, billing, collections receiving and processing applications for service, service connections and disconnections. In addition, commercial/customer service team members managed customer education and communications designed to promote understanding of PPSELD utility operations and to build a bridge of trust with the communities served by PPSELD. The commercial/customer service department also continued to manage an aggressive loss control program, carrying out activities to detect theft by customers and illegal connections.

CIP clients

During the last two years of the project, the number of clients in the CIP remained unchanged as shown in Table 2.

Table 2. CIP client count by month and by year.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	11	11	11	11	13	11	11	11	14	13	12	11
2021	11	11	11	11	11	11	11	11	11	11	11	11
2022	11											
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	11	11	11	11	13	11	11	11	14	13	12	11
2021	11	11	11	11	11	11	11	11	11	11	11	11
2022	11											

Residential and commercial clients outside CIP

Residential clients represent 97% of all clients at PSELD, 2% of the clients are commercial and 1% public facilities . Over the course of PSELD-T, the number of non-CIP clients has increased in number as shown in Table 3.

Table 3. Non-CIP PPSELD clients

2020-2021	2020											2021
Customers	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Residential	13,546	13,551	13,535	13,515	13,477	13,497	13,508	13,468	13,411	13,376	13,345	13,317
Commercial	211	200	196	196	197	197	195	200	202	209	211	215

Org. Public	33	34	34	34	34	33	36	36	36	35	36	36
Org. Autonomy	62	62	62	63	63	63	66	68	69	71	71	71
Tax Exempt	3	3	3	3	3	3	3	3	3	3	3	3
General power	27	29	29	29	29	29	50	55	55	67	66	66
Primary-volt consumers	4	4	4	4	4	4	4	4	4	4	4	4
Other	-	-	-	-	-	-	-	-	-	-	-	-
Total	13,886	13,883	13,863	13,844	13,807	13,826	13,862	13,834	13,780	13,765	13,736	13,712

2021-2022	2021											2022
Customers	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Residential	13,278	13,279	13,247	13,244	13,270	13,276	13,329	13,360	13,383	13,423	13,486	13,504
Commercial	216	220	222	228	229	232	239	242	246	249	254	258
Org Public	36	36	36	36	36	36	36	36	38	39	40	41
Org Autonomy	71	71	72	72	72	72	72	71	72	74	75	76
Tax Exempt	3	3	3	3	3	3	3	3	3	3	3	3
General power	66	66	66	66	66	66	65	67	69	68	68	69
Primary-volt consumers	3	3	3	3	3	3	3	3	3	3	3	3
Other	-	-	-	-	-	-	-	-	-	-	-	-
Total	13,673	13,678	13,649	13,652	13,679	13,688	13,747	13,782	13,814	13,859	13,929	13,954

The client's penetration rate by municipality is illustrated in Table 4 for February 2020. Forty-one percent of households are connected to PPSELD electricity service in the five communes.

Table 4. Penetration rate by commune

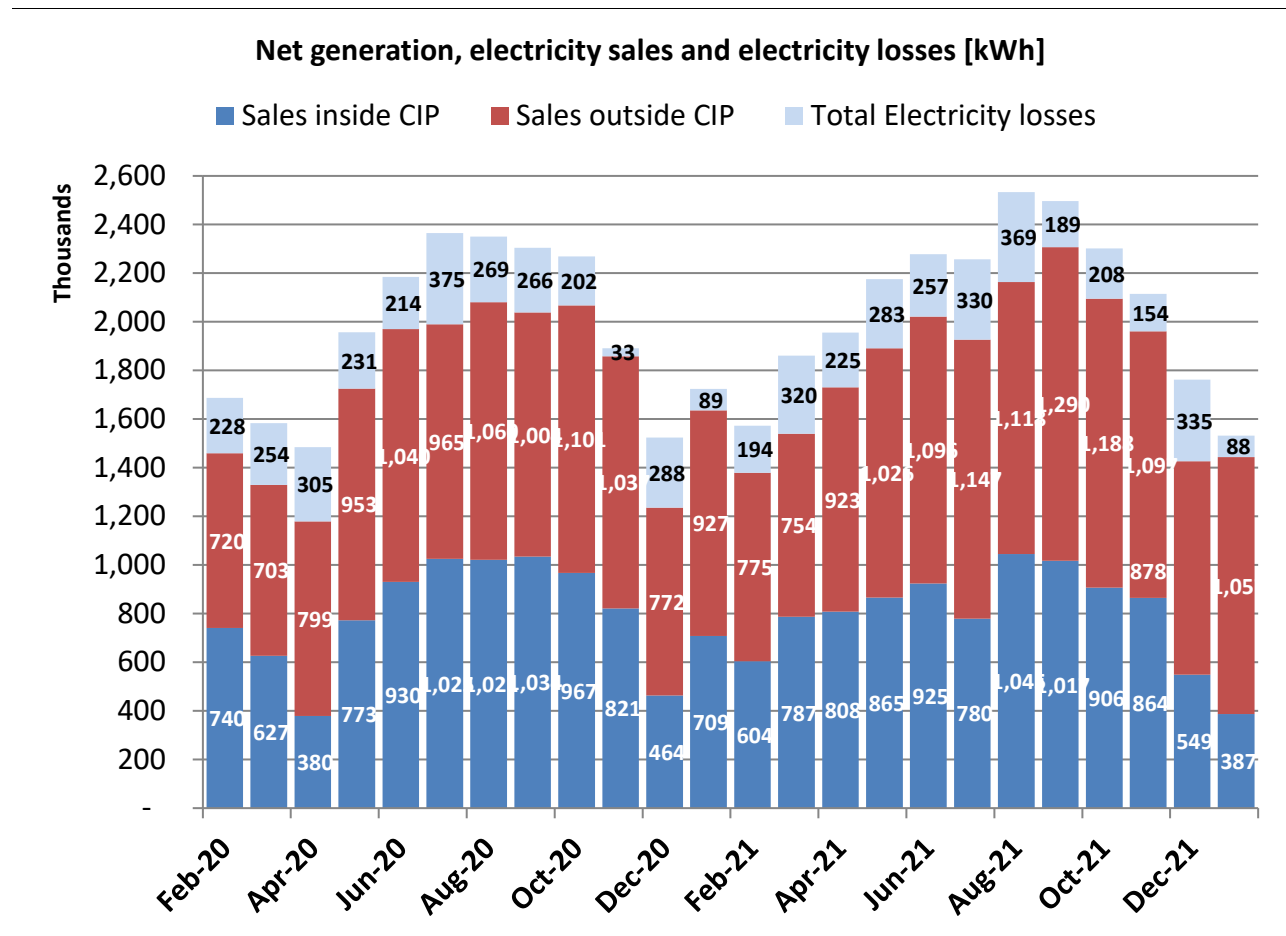
Total Client Base Outside CIP			
February 2020			
Commune	Clients	Penetration Rate	Households
Caracol	2,245	125%	1,800
Trou-du-Nord	6,030	66%	9,204
Sainte Suzanne	301	5%	5,560
Terrier Rouge	1,704	27%	6,326
Limonade	3,606	33%	10,840
Total	13,886	41%	33,730

The PPSELD distribution system does not cover all parts of the five communes, this is why the penetration rate in some of them is still low. It is estimated that around 90% of the clients with the area of influence of PPSELD transformers are connected to PPSELD service.

Electricity delivered, sales and losses

The figure 1 below presents electricity generated and distributed by the PPSELD power plant and through the distribution system for the contract period. Figure 1 also differentiates electricity sold to CIP clients and that sold to residential and commercial clients outside CIP. Over this period, 39% of the electricity was sold to CIP clients, 49% sold to residential and commercial clients with 12% losses.

Figure 1. Net generation, electricity sales and electricity losses



Electricity sales

Electricity sales were registered throughout PSELD-T for CIP (industrial) clients, residential and commercial clients. Electricity rates are denominated in dollars for industrial clients inside CIP and in HTG for residential and commercial clients outside the park.

Sales to industrial clients

Sales of electricity to industrial clients increased as some clients increased activities that resulted in higher demand. The company with the highest consumption accounts for 35% of electricity sales and 70% of all industrial sales. Table 6 illustrates industrial electricity sales by month and year in MWh.

Table 6 Industrial sales by month in MWh.

Energy Sold inside CIP - Industrial Clients

Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21
740	627	380	773	930	1,025	1,021	1,034	967	821	464	709
Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22
604	787	808	865	925	780	1,045	1,017	906	864	549	387

Residential and commercial sales

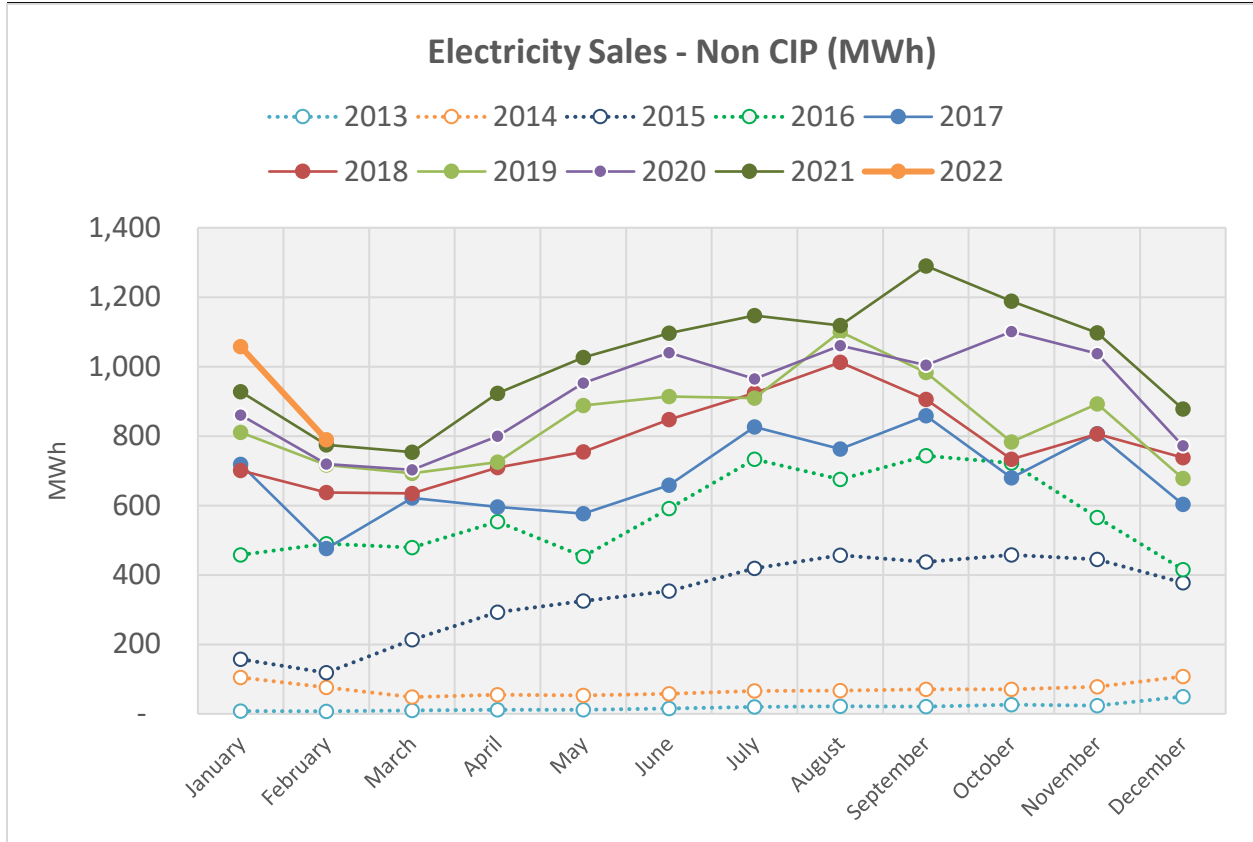
With the increase in residential and commercial consumers served by PSELD-T, sales to these consumers increased significantly. While sales to industrial clients remain significant, residential and commercial sales account for more than half of all PPSELD sales. Table 7 illustrates the progression of sales in MWh per year, while Figure 2 provides a similar illustration of sales per month during the last two year of residential and commercial sales. Residential sales represent 87% of sales while commercial clients consume 6% and other clients – such as public facilities, represent 7% of electricity sales.

Table 7 Electricity sales in MWh, Feb 2020 – Jan 2022.

Customers	2020											2021
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Residential	549	555	640	783	855	796	857	798	850	811	597	742
Commercial	65	58	68	91	108	89	82	66	77	64	52	64
Organization Public	8	9	10	14	13	14	15	14	13	13	8	10
Organization Autonomy	18	18	17	17	18	13	20	20	24	24	18	21
Tax Exempt	10	11	12	5	1	1	1	1	1	2	1	2
General power	24	30	39	38	41	47	79	85	98	101	75	77
Primary voltage consumers	26	22	15	5	5	5	6	20	39	22	21	11
Other	-	-	-	-	-	-	-	-	-	-	-	-
Total	701	703	799	953	1,040	965	1,060	1,004	1,101	1,037	772	927

Customers	2021											2022
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Residential	621	608	742	829	886	938	914	1,052	962	884	723	880
Commercial	49	47	60	69	75	76	71	81	76	71	55	64
Organization Public	9	10	11	14	12	12	14	18	14	7	6	6
Organization Autonomy	19	18	22	22	23	21	21	24	24	21	19	23
Tax Exempt	2	-	2	1	5	1	1	1	1	1	1	1
General power	68	65	81	84	82	85	81	90	90	90	69	78
Primary voltage consumers	7	6	6	7	12	14	18	25	22	23	5	5
Other	-	-	-	-	-	-	-	-	-	-	-	-
Total	775	754	923	1,026	1,096	1,147	1,118	1,290	1,188	1,097	878	1,057

Figure 2. Industrial electricity sales in MWh by month and year.



Public lighting

Public lighting is a service negotiated between PPSELD and each municipality to promote security throughout the communes that are served. Electricity consumption by street lights is evaluated quarterly based on the number of lamps installed and the energy consumption of each lamp. Agreements with each municipality state that PPSELD is responsible for installation of street lights and collects fees by assessing these fees to consumers on monthly bills. Public lighting fees are a percentage of the total electricity billed to individual consumers. . Table 8 shows the public lighting consumption per month from February 2021 to January 2022.

Table 8. Consumption in MWh per month

Commune	2021											2022
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Caracol	4.30	4.76	4.60	4.76	4.60	4.76	4.76	4.60	4.76	4.60	4.76	4.76
Ekam	1.74	1.92	1.86	1.92	1.86	1.92	1.92	1.86	1.92	1.86	1.92	2.27
Trou du Nord	12.24	13.55	13.11	13.55	13.11	15.37	15.37	14.87	15.37	14.87	15.37	15.37
Sainte Suzanne	0.93	1.03	0.99	1.03	0.99	1.03	1.03	0.99	1.03	0.99	1.03	1.03
Terrier Rouge	4.07	4.51	4.37	4.51	4.37	4.51	4.51	4.37	4.51	4.37	4.51	5.34
Limonade	5.49	6.08	5.88	6.08	5.88	6.08	6.08	5.88	6.08	5.88	6.08	6.08
	28.76	31.85	30.82	31.85	30.82	33.67	33.67	32.58	33.67	32.58	33.67	34.84

Tariffs

During the PSELD-T transition period, tariffs remained unchanged as directed by USAID. USAID and the GoH made this decision to avoid creating social unrest. Table 9 illustrates the rate schedule applied during the last two years.

Table 9. PSELD-T rate schedule applied through 2022

Category	Charge	Unit	Rate	Comments
Customer located outside the Caracol Industrial Park				
Residential consumers, 120 V service				
R	Fixed charge	Gds/month	207.00	
	Variable charges			
	0-30 kWh	Gds/kWh	16.84	
	31-200 kWh	Gds/kWh	22.39	
	>200 kWh	Gds/kWh	31.16	
Residential consumers, 240 V service				
R240	Fixed charge	Gds/month	207.00	
	Variable charge – all consumption	Gds/kWh	32.37	
Commercial consumers, 120 V service				
C	Fixed charge	Gds/month	207.00	
	Variable charges			
	0-30 kWh	Gds/kWh	16.84	
	31-200 kWh	Gds/kWh	22.39	
	>200 kWh	Gds/kWh	31.16	
Commercial consumers, 240 V service				
C240	Fixed charge	Gds/month	207.00	
	Variable charge – all consumption	Gds/kWh	32.37	
Public Institutions				
P	Fixed charge	Gds/month	207.00	
	Variable charge – all consumption	Gds/kWh	32.37	
Nonpublic Institutions				
N	Fixed charge	Gds/month	207.00	
	Variable charge – all consumption	Gds/kWh	32.37	
Streetlights				
G	Fixed charge	Gds/month	207.00	
	Variable charge – all consumption	Gds/kWh	32.37	
General service – Low voltage				
LV	Fixed charge	Gds/month	207.00	
	Variable charge	Gds/kWh	32.37	
General service – Medium voltage				

Category	Charge	Unit	Rate	Comments
MV	Fixed charge	Gds/month	207.00	
	Variable charge	Gds/kWh	32.37	
Other charges				
	New application fee	Gds	500.00	All categories
	Service relocation fee	Gds	500.00	All categories
	Account name change	Gds	500.00	All categories
	120V to 240V voltage change request	Gds	5,800.00	
	Reconnection after disconnection for non-payment fee- R, R240, C, C240, P, N and G categories	Gds	200	
	MV and LV categories	Gds	20,000	
	Meter test	Gds	1,500	All categories
	Repair fees ¹			
	Repair of service drop cable – 120 V service	Gds	4,800	
	Repair of service drop cable – 240 V service	Gds	5,800	
	Repair of meter base installation– 120 V service	Gds	4,700	
	Repair of meter base installation– 240 V service	Gds	5,100	
	Relocate meter and meter base installation	Gds	3,000	
	Change damaged meter	Gds	4,300	
	Meter seal repair	Gds	1,000	
	Replace or replace of lift pole	Gds	38,800	
	Fraud / electricity theft penalty- Residential	Gds	25,000	
	Fraud / electricity theft penalty- other categories	Gds	50,000	
	Outage request	Gds	18,700	All categories
	Interconnection engineering study	Gds	40,0000	All categories
Reimbursable security deposits				
	R and C categories	Gds	1,500	
	R240 and C240 categories	Gds	6,000	
	Other categories	Gds	TBD	²
Customer located inside the Caracol Industrial Park				
Fixed and variable charges for all consumers				
	Fixed charge	US\$/month	10.00	
	Variable charge – all consumption	US\$/kWh	0.30	
Other charges				
	New application fee	US\$	12.00	All categories
	Reconnection after disconnection for non-payment fee	US\$	200.00	All categories
	Outage request /	US\$	200.00	Including meter test requests
	Interconnection engineering study	US\$	400.00	
	Repair fees	US\$	³	
	Fraud / electricity theft penalty	US\$	1,000	
	Reimbursable security deposits	US\$		⁴

All charges above are subject to 10% sales tax (TCA), except customers located inside the CIP as well as tax exempt customers outside the CIP.

¹ All categories but LV and MV

² Based on 2 months of anticipated electricity consumption including all applicable chargers

³ Repair fees for LV and MV categories outside the park, or for all consumers inside the park, are to be determined equally to the needed repair work on a case-by-case base, considering all labor and materials costs

⁴ Based on 2 months of anticipated electricity consumption including all applicable chargers

Customer Service - Meters reading, billing and collections.

PPSELD clients' meters are read on a monthly basis. Customers are billed based using meter readings to evaluate actual electricity consumption. The meter reading and billing process is as follows:

- The service area is divided in 154 meter-reading routes. Meter technicians are assigned to specific routes to read meters and deliver bills. Meter technician read the meter, enter the reading in a tablet computer and print the bill on site to deliver to the client.
- Meters are read each month.
- All meters in a route are read on the same day.
- The collected readings are updated in CIS. Commercial department staff review and confirm bills issued by technicians in the field.
- Large CIP consumers and some larger institutions receive bills via email.
- Payments are due 14 days after the meter is read.

Figure No 3 illustrates the activities of the reading, billing, and billing delivery to the client.

Customers may pay bills at any PPSELD office or collection point that are interconnected to the CIS. Walk-in customers interact with PPSELD customer service representatives who receive payment and provide a receipt for the transaction. The larger customers can transfer funds via direct deposit to the PPSELD bank account.

Cash received at PPSELD collection points is counted and prepared for deposit after the office is closed to the public. A cash reconciliation is carried out the next morning at the PPSELD main offices to ensure the amounts counted and received are correct. After reconciliation, payments are recorded in the system, and cash is deposited.

Figure 3. Meter reading, billing, and bill delivery on site



Web CIS

The webCIS is composed of eight modules including an administration module, a customer management module, a billing module, a cashier module, an accounting module, an energy management module, a user management module and a reporting module. The webCIS is designed to interface with customer service personnel via a web application. All users connect to the CIS through an internal network or remotely. No other applications are required on user's laptop to connect to the CIS. The modules have the following features.

Administration module

- Tariff definition, tariff charges and fee set up, including definition of streetlight surcharges
- Definition and management of accounting codes for billing and collection transactions
- Creation and management of meter reading routes
- Set up and management of poles, transformers, and routes
- Management and set up of field offices and collection points

Customer Management module

- Customers' information data (name, address, phone, etc.)
- Management of customers' account data, including tariff, location, pole and transformer linkage, route, tariff, etc.
- Management of meters including location, status (energized, disconnected, etc.)
- Customers' general ledger
- Management of meter installation order (Meter Order) includes all steps required to install or remove a meter at a customer's premise.
- Management of service orders
- Management of customer complains

Billing module

- Billing of routes, including meter reading, billing, and noting abnormalities and printing of bills.
- Generation of meter disconnection lists for non-payment and meter reconnection lists
- Management of do-not-disconnect list
- Management and oversight of adjustments to customer's general ledger (credits or debits)
- Management and oversight of fraud fees

Cashier module

- Receiving customers' payment and printing of payment receipts
- Customer reimbursement module and printing of payment receipts
- Collection summaries for reconciliation of cash collection by office and customer service representatives

Accounting module

- Reports of transactions for billing and collection revenues
- Generation of daily and monthly transaction summaries

Reporting module

- Several reports of electricity sales, billing and collection used for operations

Energy balance module by distribution transformer

User management module

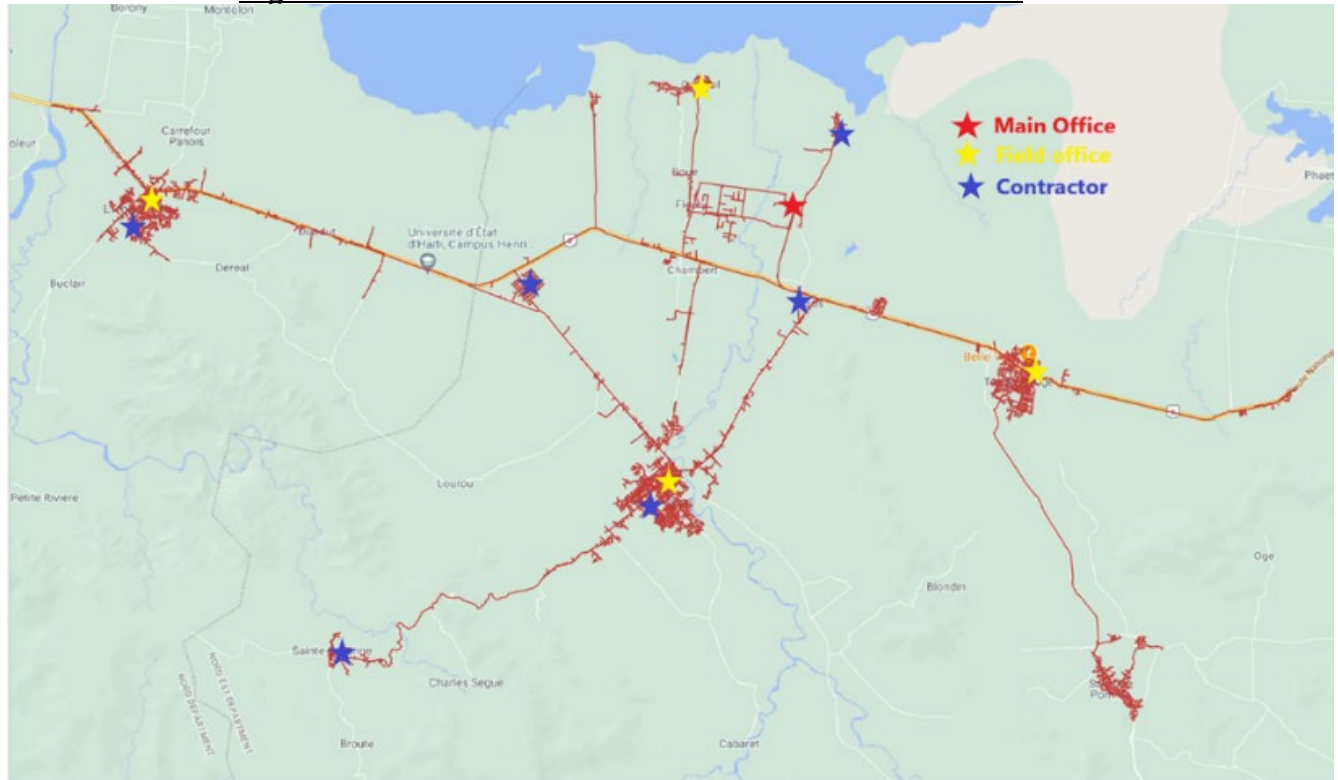
- Management of user attributes, hierarchies and security level, and activity log.

District offices

PPSELD has established offices strategically located to allow customers to request service connections, pay bills, register complaints, or just seek information from PPSELD customer service agents. Customer service personnel receive consumers, attend to customer requirements, and receive payments for electricity consumption. The offices are open from Monday to Friday from 7:30 a.m. to 3:30 p.m. and on Saturdays from 8:00 a.m. to 12:00 p.m.

To facilitate consumer payments, a network of collection points operated by third parties was established to facilitate customer payments. PPSELD representatives at these collection points are able to access the CIS to provide billing information and record payments. The payment agents receive a fixed payment per invoice collected. Figure 4 illustrates a map of the PPSELD district offices and third party collection agents.

Figure 4. Location of PPSELD commercial services offices.



Task 2 Operate and maintain the 10 MW generation plant, distribution grid, and ancillary equipment

Electricity power generation plant

The CIP power plant consists of six generating units, each of which has a maximum capacity of 1.7 MW. These generators are designed to burn heavy fuel oil or diesel fuel, depending on fuel availability and cost. The plant was designed and built by ESD Engineering and Service SRL under contract with USAID.

The generation department consists of operations and maintenance teams. The operations team includes three groups of four operators. The groups work rotating twelve-hour shifts to provide a 24-hour service. The operators were trained to operate all the generation units, the boiler equipment and the fuel tank farm. NRECA advisors, managers, and safety coordinator supervise

all operations and maintenance activities at the power plant as well as provide periodic training of the generation team.

The maintenance team is composed of mechanical and electrical teams. The two maintenance teams are responsible for maintaining and repair of the power plant to ensure the availability of all components in the plant. The generation maintenance personnel perform preventive and corrective maintenance following manufacturer instructions for all the equipment installed in the plant, including six generators and auxiliary equipment. The result of the generation team has been outstanding; the PPSELD plant is recognized as the most reliable plant in Haiti with an availability index of 99.56% for January 2022. Table 10 illustrates plant production for the PSELD-T performance period. Table 11 illustrates the maximum demand for each month of the performance period.

Table 10 Total Gross Production per Month – kWh

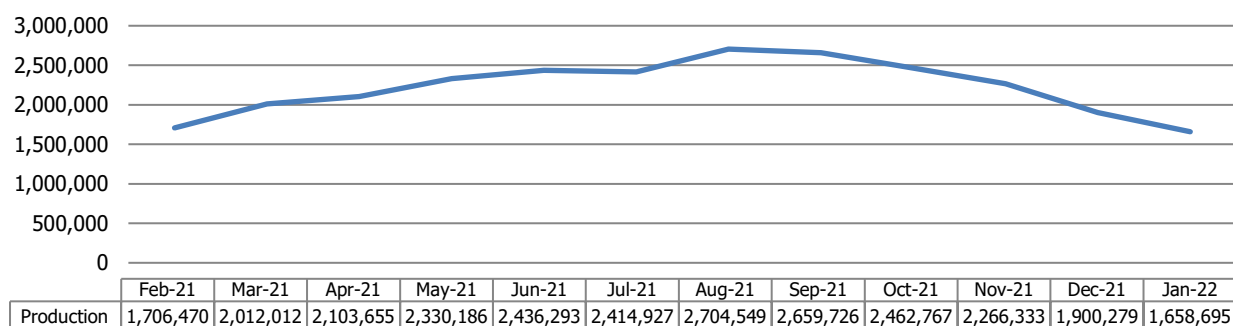
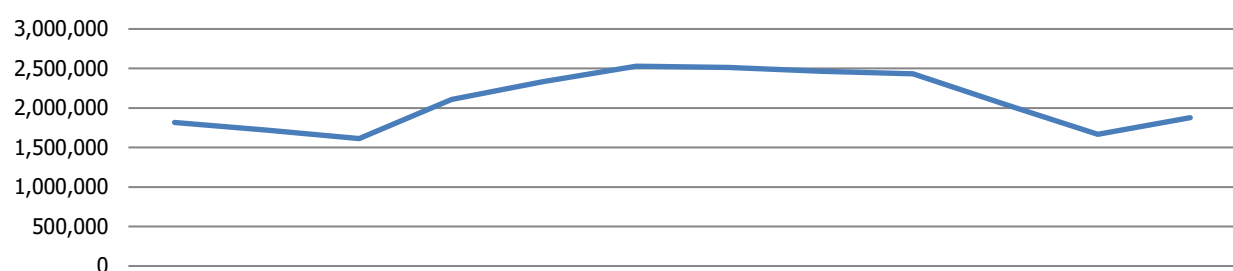
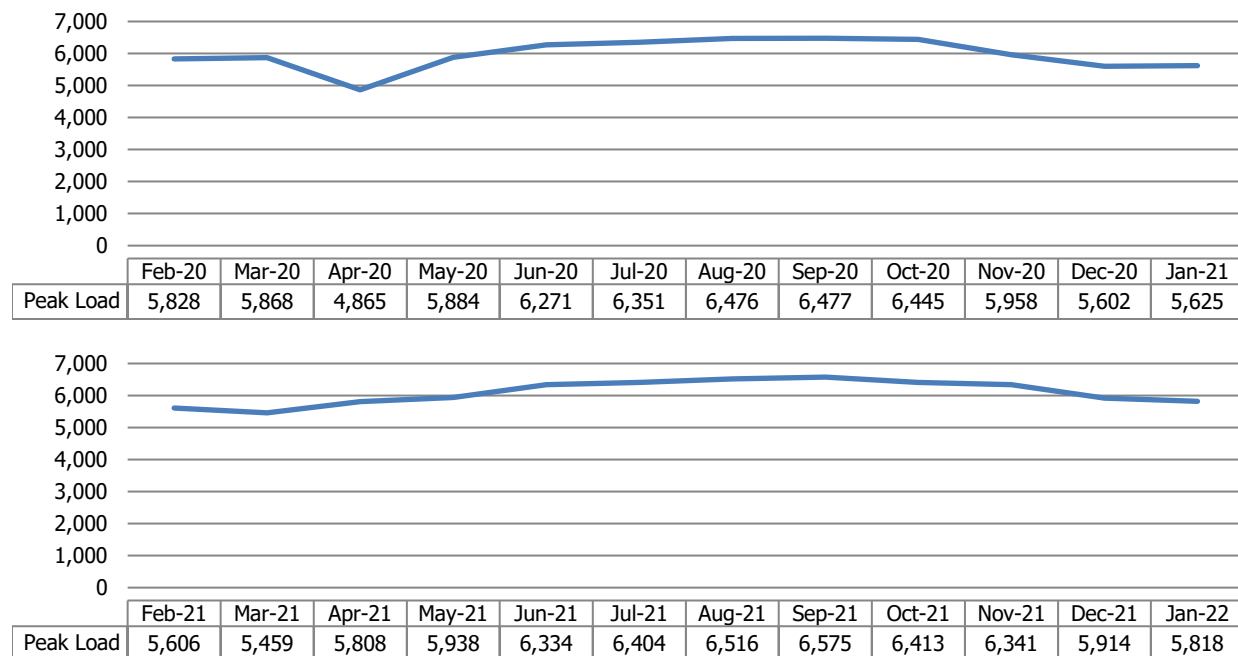


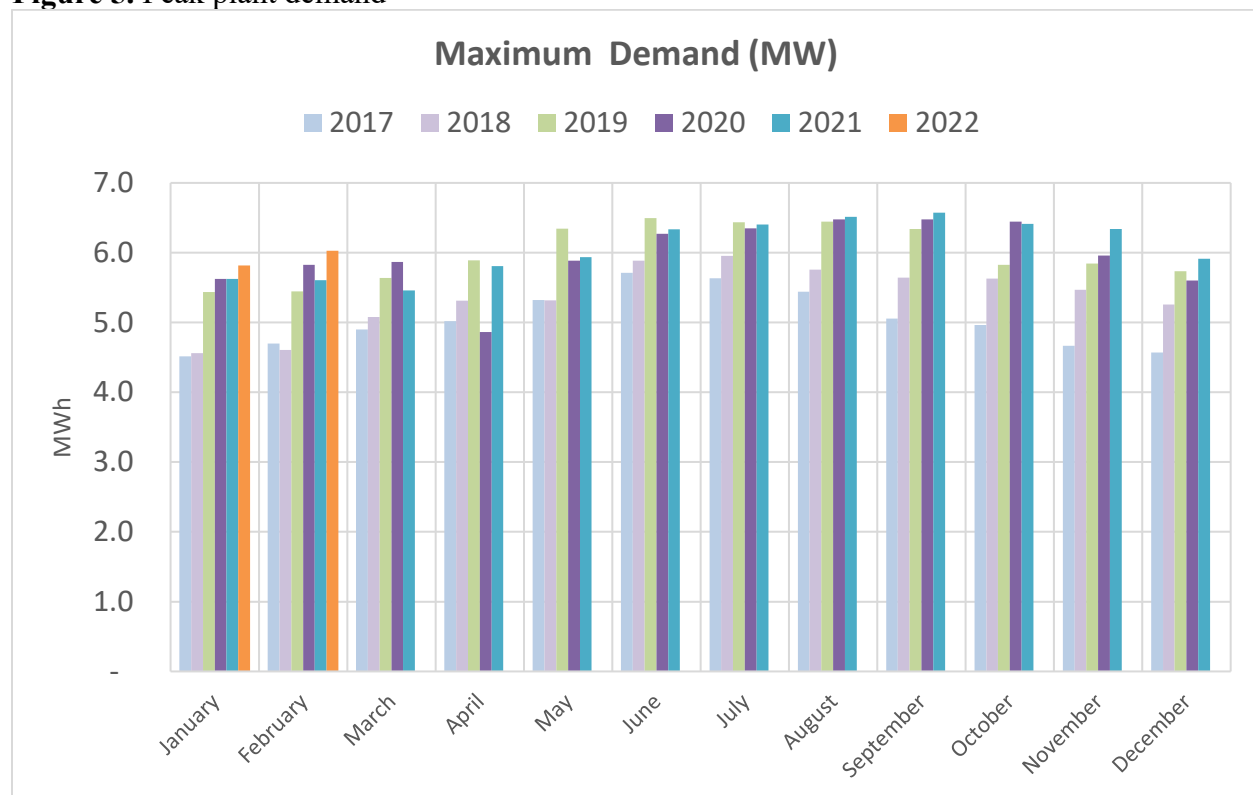
Table 11. Total Plant Max Demand per Month kW



During the period of February 2020 through January 2022, electricity generation reached 51.7 GWh while the fuel consumption was approximately 3.3 million gallons, diesel and HFO. In average 15.66 kWh per gallon of fuel was produced.

The maximum demand registered in the same period was in the month of September 2021, 6,575 kW. Figure 5 illustrates the demand by year and month throughout the last five years of PPSELD operation.

Figure 5. Peak plant demand



Preventive maintenance

The power generation station consists of six 4-stroke, vertical, direct injection, single acting and trunk piston type generators with turbocharger and inter-cooler. These six units are containerized. Total hours of operation as of January 31, 2022 for each unit are shown in Table 12 below.

Table 12. Hours of operation of each generator unit

Genset	Hour Meter as of January 31, 2022
MDU NO.1	24,705
MDU NO.2	33,052
MDU NO.3	34,902
MDU NO.4	30,701
MDU NO.5	25,461
MDU NO.6	27,630

Preventive maintenance includes a combination of minor and major maintenance procedures as prescribed by the manufacturer. Manufacturer recommendations state that minor preventive maintenance should be performed every 3000 hours of operation while major maintenance should be performed once every 12,000 hours. Maintenance procedures are specified for each occurrence of minor and major maintenance. The maintenance team maintains records of all preventative and corrective maintenance procedures undertaken for all generation units.

Minor preventive maintenance

The scope of maintenance required is very similar for minor maintenance that is prescribed for maintenance intervals of 3,000, 6,000, 9,000, 15,000, 18,000, and 21,000 hours. These maintenance procedures include inspection of all top-end (compression chamber) components of the engine, replacement of the injection nozzles if heavy fuel oil has been used, and repair of all issues identified in the inspection process.

Inspection procedures require inspection of the axial clearance of the crankshaft, confirmation torque settings for connecting rods; inspection of the main/big end bearings and the timing gear and other related inspection procedures. In addition, minor electrical preventive maintenance procedures are performed according to the manufacturer's recommendations. Table 13 summarizes the dates when minor maintenance was performed.

Table 13. Minor Preventative Maintenance

Minor Preventive Maintenance Performed during the Project Feb/2020 to Jan/2022				
Genset	18000 hrs.	21000 hrs.	27000 hrs.	30000 hrs.
MDU No1	August 2,020	June 2,021		
MDU No2		August 2,021	November 2,020	August 2,021
MDU No3			May 2,021	
MDU No4			June 2,21	
MDU No5	April 2,020	February 2,021		
MDU No6		March 2,020	January 2,022	

Major preventive maintenance

Major preventative maintenance is required every 12,000 hours of generator operation. The manufacturer recommendations require that all components of the generator must be thoroughly inspected to identify any anomalies in major systems or components. The inspection considers any anomalies identified in the operating record to guide the inspection and discovery process. Manufacturer recommendations also include replacement of bearings, injectors, oil and compression rings, and other major components. Service technicians are required to measure major and minor components to determine if they are within proper operating specifications – and to replace components that are outside of operating compliance. With respect to electrical maintenance, major maintenance procedures are also specified in the manufacturer guidebooks. Service technicians are required to ensure that the engine is left in optimal condition at the conclusion of major maintenance processes. Table 14 shows the dates when major maintenance was performed for the six genset units.

Table 14. Gensets Major Preventive Maintenance

Gensets Major Preventive Maintenance Feb/2020 to Jan/2022	
Genset	24000 Hrs.
MDU No1	
MDU No2	January 2,020

MDU No3	August 2,020
MDU No4	October 2,020
MDU No5	
MDU No6	April 2,021

*200 hrs. inspection is performed after a major maintenance

Ancillary Equipment

Like all equipment installed in the plant, auxiliary equipment plays an important role in the operation of PSELD power plant. PPSELD team members carried out the respective maintenance to ensure that they operate efficiently and effectively to ensure their continued availability. Air compressors required to initiate diesel/HFO starting conditions, as well as to produce compressed air for the instrumentation system, are inspected daily. If problems are noted, maintenance is scheduled immediately. Other components that are inspected daily include engine oil centrifuges; HFO centrifuges; and the exhaust gas recovery boiler that produces the steam to heat HFO. This boiler is fueled by diesel and heavy fuel oil. It produces steam that is required to support continued operation heavy fuel oil when a maintenance is required on the exhaust gas recovery boiler.

Firefighting system of the plant

An essential system for all generation plants is the fire protection system. Fire extinguishers are installed throughout the plant, but the primary fire suppression system is a water system that supplies eleven fire hydrants strategically located throughout the plant. They must always be operable therefore they are inspected routinely to ensure that they operate efficiently and effectively to ensure their continued availability.

Other important corrective maintenance carried out during the PSELD-T project. Table 15 below summaries additional maintenance work performed at the auxiliary equipment of the generation plant.

Table 15. Additional Maintenance Work

Other important maintenance work performed Feb/2020-Jan/2022		
Equipment	Description of Work	Date
HFO System	Installation of new viscosity sensors and interface in HTU side 1 and 2.	February 2020
Firefighting System	Replacement of defective batteries on the Diesel pump. Maintenance of 480/220 V transformer in firefighting system.	February 2020
Genset # 1,2,3,4,5 and 6.	Coordination of electric protections and changing of parameters on the Generator paralleling controller (GPC's).	May 2020
LO separator # 1	Major maintenance	July, 2020
Steam exchanger # 2	Corrective maintenance on HFO booster system # 2	July, 2020
MDU No. 1	Corrective maintenance on cylinder head No. 5.	July, 2020
MDU No. 3	Corrective maintenance on injection pumps cylinders #7 and #8	September 2020
MDU No. 1	Change of oil scrapper and compression rings on all cylinders due high oil consumption	December 2020.
Air compressor # 1	Major maintenance	February 2021
Steam exchanger # 1	Corrective maintenance on HFO booster system # 1	May 2021
MDU No. 4	Preventive maintenance on turbocharger	September 2021

Laboratory tests

During the 24-month period of PSELD-T implementation, routine tests have been carried out on a periodic basis to evaluate power plant performance and identify potential maintenance requirements. Monthly tests have been conducted for lubrication oil, cooling water for the six engines and for the heavy fuel oil used in our engines. Every month exhaust gas recovery boiler water and the auxiliary boiler were analyzed.

Electricity Distribution System

When USAID and GOH authorized expansion of service to the communes of Troud Du Nord, Terrier Rouge, Limonade, NRECA started to rehabilitate former EdH distribution infrastructure and to normalize former EdH consumers. Former EdH distribution were in a very poor conditions in some segments requiring full replacement. Due to challenges with hiring qualified contractors to perform distribution rehabilitation services, PPSELD trained locally hired linemen to perform rehabilitation services. These local staff not only gained confidence from this training experience but also acquired the skills needed to perform maintenance work practices through the construction training experience. PPSELD employees were trained by NRECA staff members who were assisted in great part by NRECA member cooperative volunteers who traveled to Haiti on a voluntary basis to provide assistance. After an intensive period of rehabilitation by January 2022, 70 km of medium voltage lines of lines were rehabilitated, and 138 km of lines were added. As January 2022, PSELD-T have 252.86 km of lines as it is described at Table 16 below and 536 distribution transformers installed at the CIP and outside the CIP as it is shown at the Table 17, Distribution transformers by Commune.

Table 16. PSELD-T Distribution lines by Commune

Description	Caracol km	Troud Du Nord km	Saint Suzanne km	Tierre Rouge km	Limonade km
Three phase primary lines	18.60	5.17		3.47	3.84
Single phase primary lines	8.66	3.74	5.69	1.49	2.25
Under build three phase	1.73	11.22		3.4	6.95
Under build single phase	10.87	11.62	2.44	4.78	10.64
Secondary	16.60	54.27	3.55	25.95	31.32
DCKT*	4.34				
DCKT* - UB	0.27				
Sub-totals	61.07	86.02	11.68	39.09	55.00
TOTAL PSELD-T	252.86				

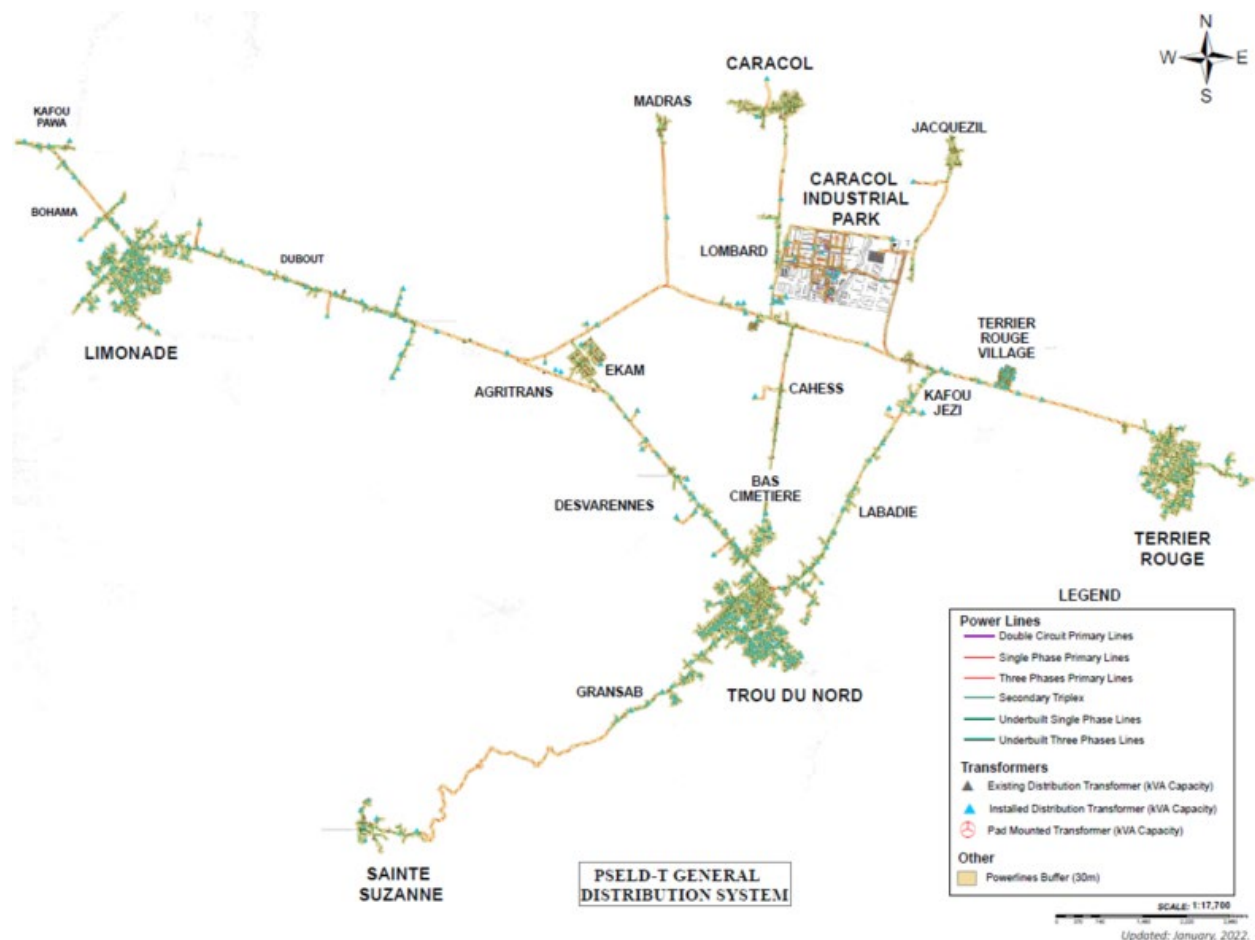
*Double circuit at CIP

Table 17. PSELD-T Distribution transformers by Commune

Capacity	Caracol kVA	Troud Du Nord kVA	Saint Suzanne kVA	Tierre Rouge kVA	Limonade kVA
10kVA(1Ph)	24	36	1	12	12
15kVA(1Ph)	62	58	3	12	37
25kVA(1Ph)	16	59	3	21	41
37.5kVA(1Ph)	17	15	4	1	21
50kVA(1Ph)	3	3		10	
75kVA(1Ph)	1			1	
100kVA(1Ph)	1				
30kVA(3Ph)	1				
45kVA(3Ph)	6	1			2
75kVA(3Ph)		1			2
112.5kVA(3Ph)	3				
150kVA(3Ph)	7				
225kVA(3Ph)	20	1			
300kVA(3Ph)		3			1
500kVA(3Ph)	2				
750kVA(3Ph)	11				
1000kVA(3Ph)					1
Sub-total	174	177	11	57	117
Total	536				

Figure 6 describes the PSELD-T service area and the location of the distribution transformers.

Figure 6. PPSELD service area.



During this transition period, PSELD-T maintained the electricity service to its users at high levels of reliability. The table 18. PSELD-T average service availability index below shows the results month by month. For the year of 2020, 99.66% of reliability was recorded and for the next year of 2021, 99.75%.

Table 18. PSELD-T average service availability index

2020				
Month	Number Outages	SAIFI	SAIDI	ASAI (%)
January	11	0.60	2.30	99.69%
February	10	0.10	0.20	99.98%
March	12	6.00	1.70	99.76%
April	8	0.03	0.10	99.98%
May	42	2.10	10.70	98.57%
June	11	0.60	1.00	99.97%
July	21	0.80	2.70	99.64%
August	12	1.90	3.30	99.56%
September	12	3.10	5.30	99.27%
October	7	1.30	2.80	99.63%
November	5	0.20	0.40	99.94%
December	5	0.10	0.20	99.98%
Total/Average:	156	16.83	30.70	99.66%

2021				
Month	Number Outages	SAIFI	SAIDI	ASAI (%)
January	6	0.80	2.20	99.70%
February	5	0.20	0.50	99.93%
March	9	0.10	0.20	99.97%
April	9	0.80	3.10	99.56%
May	11	0.40	1.40	99.82%
June	17	2.60	7.40	98.98%
July	11	1.80	2.40	99.67%
August	13	0.40	0.70	99.91%
September	10	0.80	1.40	99.81%
October	6	0.10	0.20	99.97%
November	8	0.60	1.30	99.81%
December	13	0.40	1.10	99.85%
Total/Average:	118	9.00	21.90	99.75%

2022				
Month	Number Outages	SAIFI	SAIDI	ASAI (%)
January	13	2.90	4.70	99.37%

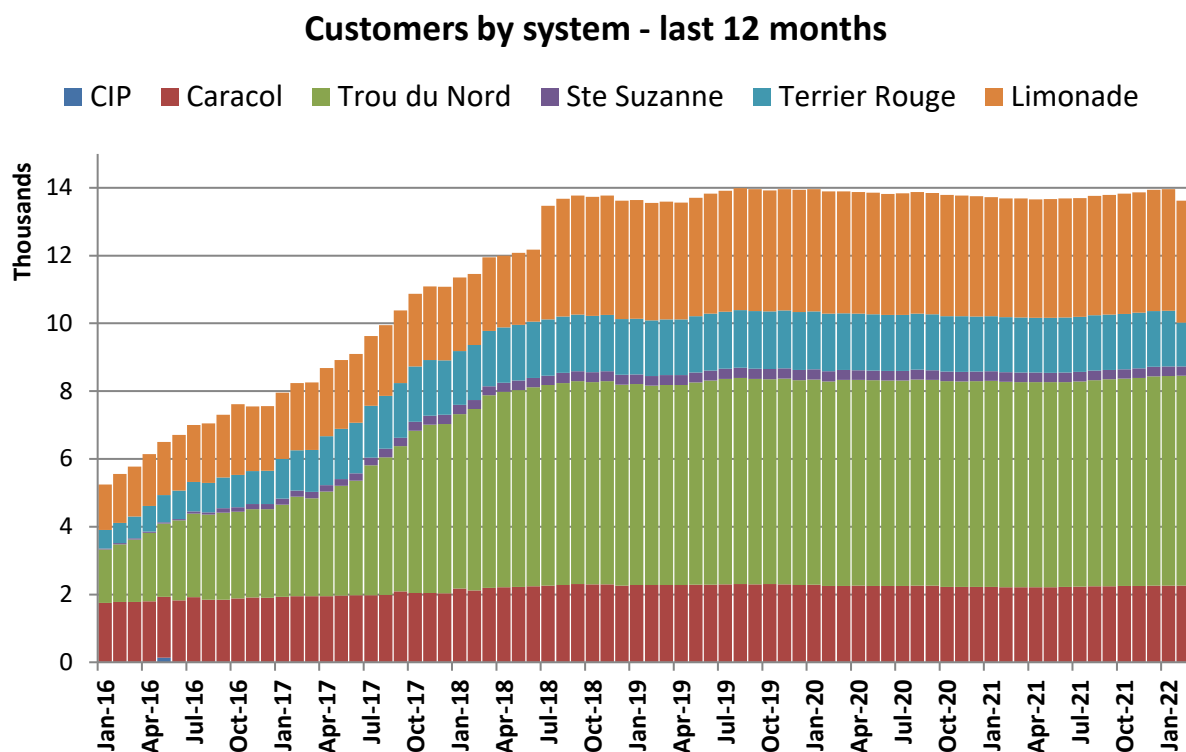
Note: The flooding that occurred in the Industrial Park and the PSELD generation plant - interrupted the service in the entire PSELD-T system on the last day of January 2022.

Task 3. Reduce Non-technical Electricity Loss by Increasing Metered Customers.

Customer normalization and connection of new clients

Once the process of rehabilitation of the medium and low voltage system was completed and the normalization of the clients was completed, the number of clients increased, therefore, the sales of electricity increased and the losses began to decrease. But at the same time, the task of control of illegal connections was initiated to continue to combat energy theft on a continuing basis. Figure 7 shows the progression of registered customers from approximately 5,000 in 2016 to approximately 14,000 in January 2022. Although 16,502 connections were made up to January 2022, in January 2022, 13,621 customers were active and with electricity service. During the period from February 2020 to January 2022, the number of clients ranged between 13,893 and 13,621.

Figure 7. Customers by system - January 2016 - January 2022



In the CIP, the number of customers served remain at the same level between 2020 and 2022. As of 2022, 11 clients are in operations inside the park. See Table 2.

Table 20 below shows the number of requests for new connections received and processed between February 2020 and January 2022. A total of 766 application were received at the offices of PPSELD from them 759 were processed and 556 meters were connected to the service.

Table 19. Customer Service Records

Description	No of Clients/ Connections
New applications received	766
New applications processed	759
Design completed	785
Meters connected	556
Customers disconnects fraud	182
Illegal connections removed	768

Electricity loss reduction program

Electricity losses occur due to the natural heat process of the conductor as electricity is conducted from one place to another, this phenomenon is called technical losses. Commercial losses occur due to theft of electricity, meter manipulation and poor or improper commercial practices such as meter reading errors, failure to deliver bills or other related commercial activities. Identification and reduction of commercial losses is a key activity required to achieve improved financial sustainability for electricity distribution companies. PPSELD created the revenue protection department to systematically and routinely identify and work to reduce electricity theft. The revenue protection team is a permanent work unit in the commercial department comprised of three crews of technicians who are responsible to constantly patrol the distribution network to search for illegal connections and inspect meters. Through the monthly loss control of the distribution transformers, the revenue protection crews are organized to inspect all the transformers with the highest losses. The distribution networks, the household connections and the meters of the clients connected to these transformers are inspected everyday including weekends. Activities performed by the revenue protection crews include:

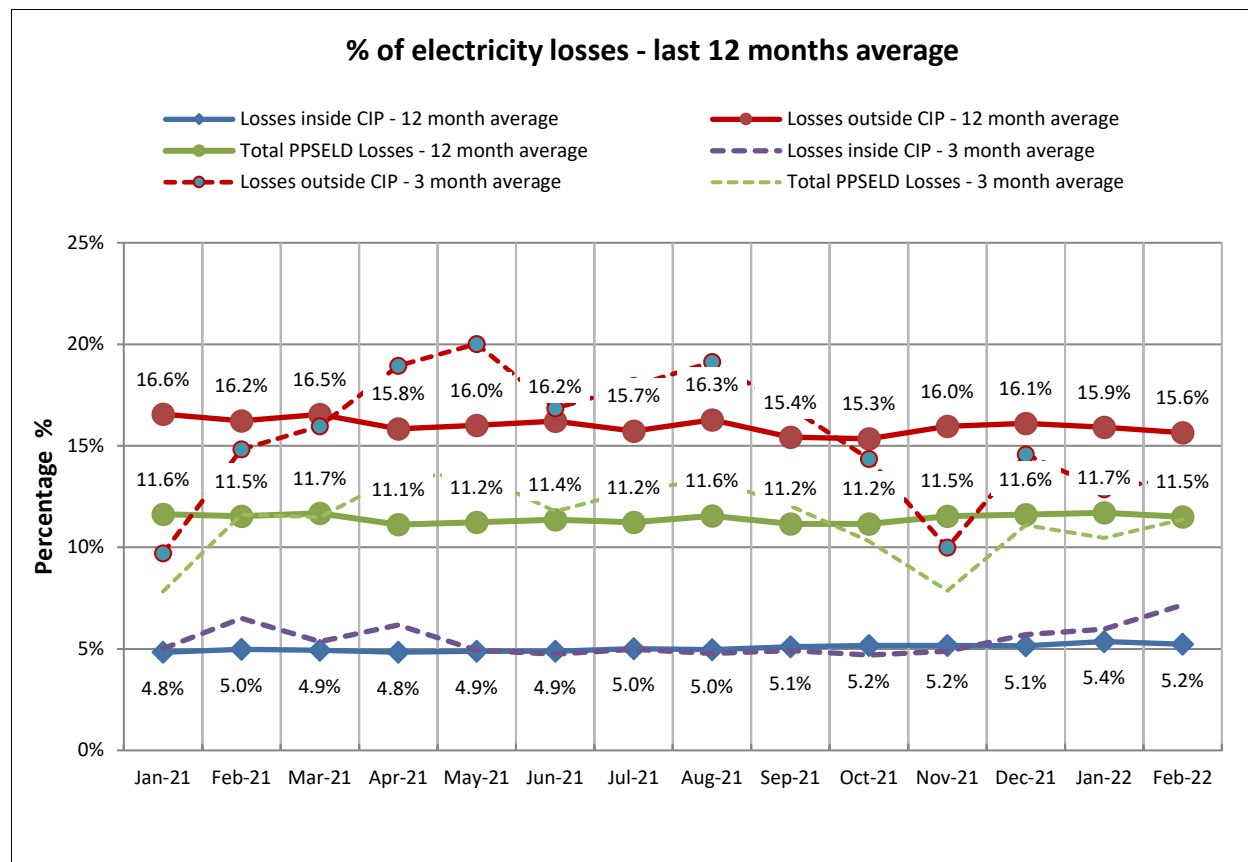
- Patrol the distribution network in search of illegal taps
- Inspection of meter bases and service drops in search for hidden meter bypasses or tampered meters
- Sweep inspections on identified trouble areas with higher losses
- Disconnection of consumer from pole found consuming electricity illegally
- Disconnect and connect areas of the system that were temporally suspended due to damages on the lines due to theft actions.
- Disconnect and remove illegal connections.
- Removal of meters and service drops from customers disconnected for non-payment after six months.

All cases of customer fraud found are sent to the customer service department to apply a fraud fee to the accounts of these customers. However, due to the COVID-19 pandemic during PSELD-T implementation, the activities of the revenue protection crews were significantly restricted to avoid contact with clients.

As Table 20 shows the results of the activities carried out by the revenue protection crews, 768 illegal connections were disconnected and 182 customers were found stealing electricity during the period of February 2020 through January 2022. Electricity losses during the last 24 months remained stable in the range of 11.5% percent. Losses within the CIP remained around 5%, while

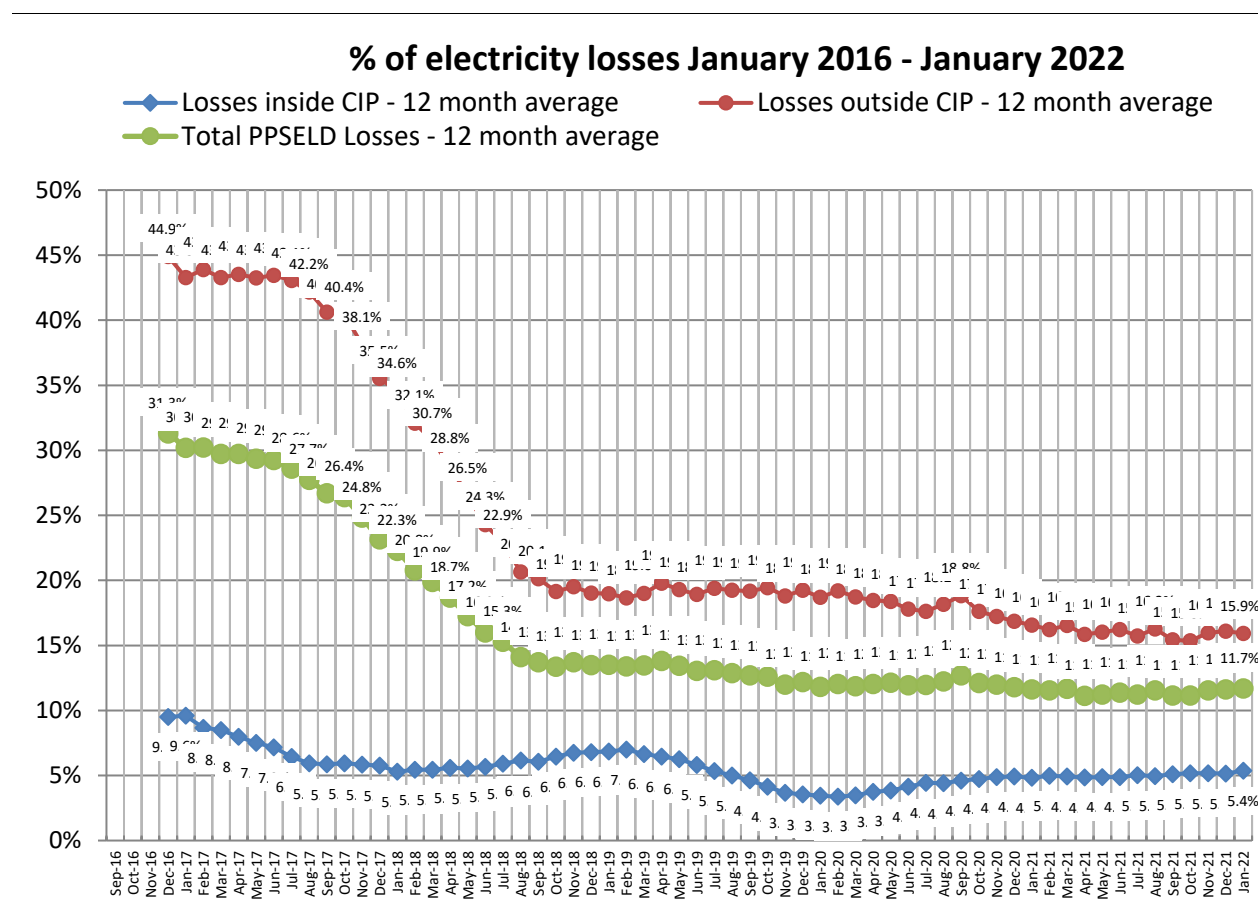
losses outside the CIP were between 15% and 16%. Figure 8 illustrates the total losses and the losses inside and outside the park during the last 12 months, from January 2021 to February 2022.

Figure 8. Electricity losses last 12 months average



The Figure 9 below illustrate the evolution of the losses from previous years.

Figure 9. Evolution of the electricity losses Jan 2016 – Jan 2022



Task 4 Facilitate transition to future private operator.

GOH, continuing with its strategy of privatizing the electricity service in the 10 departments of Haiti, put out to tender three departments, for which it received proposals and began a negotiation process, which showed great hope. During this process, the NRECA team provided support at the request of the USAID technical team, providing information on PSELD operations that served to prepare the bidding documents. Multiple meetings were held to support potential proponents and the USAID-supporting contractor in this process. Unfortunately, the negotiations with the potential candidate to operate the PSELD system did not conclude and the GoH decided to declare the tender void in October 2021. A new process is expected to restart at the beginning of 2022.