Office of Utilities Regulation

ADVANCED ELECTRICITY METERS INVESTIGATION

OFFICE OF UTILITIES REGULATION

2020 July 31

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DOCUMENT TITLE AND APPROVAL PAGE

1. DOCUMENT NUMBER: 2020/ELE/014/REP.001

2. DOCUMENT TITLE: Advanced Electricity Meters Investigation

3. PURPOSE OF DOCUMENT

This document sets out the Office's decision on Advanced Electricity Meters Investigation

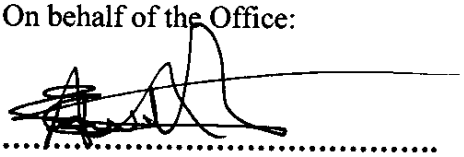
4. ANTECEDENT PUBLICATIONS

Publication Number	Publication Title	Publication Date
2020/ELE/014/REP.001	Advanced Electricity Meters Investigation	2020 July 31

5. Approval

This document is approved by the Office of Utilities Regulation and the decisions therein become effective on 2020 July 31

On behalf of the Office:



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Director-General
Ansord E. Hewitt

2020 July 31

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ABBREVIATIONS AND DEFINITIONS

AvgCPC	Average Consumption Change
GE	General Electric
JPS	Jamaica Public Service Company Limited
KDE	Kernel Density Estimator
KSAN	Kingston and St. Andrew
MTAOP	Meter Testing Administrative and Operational Protocol for the Electricity and Water Sectors in Jamaica, 2017
OUR	Office of Utilities Regulation
RAMI	Residential Automated Metering Infrastructure

1 EXECUTIVE SUMMARY

Background

The Advance Meter Testing Investigation carried out by the Office of Utilities Regulation (OUR) and set out in this document covers the period 2017 to 2019. Over this period all Jamaica Public Service Company Limited's (JPS') advanced meters were tested based on the criteria set out in MTAOP. Over this, JPS undertook rapid and widespread meter installation, replacing in many instances existing meters with digital meters. Following that development, however, the OUR received a number of complaints about high bills, particularly in the cases where meters were replaced.[1]

Following a request by the OUR, JPS conducted an investigation. However, OUR's review of JPS's report, found significant limitations in their approach, and consequently, the results and findings of that investigation were not considered to be conclusive.

While the level of customer complaint was a concern, the OUR accepted that high electricity bills could be caused by many reasons, and as such, the complaints might not have been as a result of the installation of these meters. In this context, it was critical to examine the extent of the accuracy of the advanced electricity meters JPS has installed since the **2017 Meter Testing Administrative and Operational Protocol**, (MTAOP) and whether this could be linked to the increase in customer complaints following the large –scale meter replacements on the network.

The scope of the investigation was, consequently, mainly focused on customer's accounts with meter replacements (i.e. existing meter replaced with advanced meters). Notably, previous similar investigations had been conducted by the OUR, - work including in 2011, "Investigation of the Jamaica Public Service Company Ltd (JPS) Billing and Metering System for Electricity Consumption".

Methodology

The investigation was largely driven by metering data and analysis, and so the results were highly dependent on the accuracy, completeness and relevance of the data provided by the utility.
A sample of 308 accounts were used as the basis of the investigation. Even though, this sample size is approximately 77% of the original sample of 400 accounts, it is still considered to be largely representative.
The information requested from JPS on the sample of accounts included:

- Monthly consumption data for at least twelve (12) months prior to meter change and six (6) months subsequent to meter change, for all accounts selected. This was necessary to

[1] The OUR wishes to make clear that this investigation was undertaken prior to the complaints of higher JPS billing early this year (2020), which are currently the subject of an investigation. An update on that investigation will be provided at a later date and separately from this report.

ensure like-month consumption comparison for any six-month period after the advanced meter installation; and

- Meter information for the selected accounts, including meter type, installation date and manufacturer serial number for the old meter that was replaced.

OUR's Observations from Consumption Dataset

JPS CUSTOMER CONSUMPTION DATA	
Component	**Total**
Number of Accounts (Sample Size)	400
Number of Accounts with information on Replaced Meters	335
Number of Accounts with sufficient data records to support reliable analysis	308

Main Findings

The following are the main findings of the investigation:

1. It was deduced that within the margins of error, the electricity consumption changes since meter distribution, largely showed a normal type distribution, where accounts with increased consumption are fairly balanced with accounts experiencing reductions.

2. It is not unusual for there to be large shifts in average consumption for some accounts after large-scale meter replacements, due to the probability of advanced degradation in the accuracy and performance of older meter types over time.

3. It appears that there is a relationship between the Old Meter Type and the change in consumption experienced after meter change. In particular, Old Meter Types, which are of electromechanical design, appear to have a significant relationship with above average consumption changes, after meter change.

Conclusion

The investigation concluded from the results of the analysis that the advanced meters seem to be functioning satisfactorily and are not necessarily the driver for the excessive electricity consumption and billing complaints.

The OUR has identified the following, among others, as next step activities for further analyses:

(1) The establishment of a framework to track meter installations after approvals to facilitate ongoing monitoring, future assessments and meter related audits.

(2) Further collaboration with JPS to:

- Test a sample of old meters shortly after replacement.
- Consider the treatment of old meters after their removal from service.
- Investigate meter replacements after 2019 June.

2 INTRODUCTION

2.1 PURPOSE

To investigate the extent to which the integrity and functionality of advanced electricity meters installed in the Jamaica Public Service Company Limited (JPS) network since the promulgation of the Meter Testing Administrative and Operational Protocol, 2017 (MTAOP) may be linked to customer complaints that emanated subsequent to large –scale meter replacements on the network.

2.2 BACKGROUND

Over the past three (3) years, JPS has progressively increased the deployment of advance revenue meters in its distribution network, to increase visibility/monitoring capability, improve meter reading efficiency and accuracy, and enhance billing and revenue recovery processes.

In keeping with the regulatory framework, all advanced meters installed by JPS over the stated period were subjected to the requisite testing and satisfied the approval conditions stipulated by the MTAOP. However, with the acceleration of these meter installations, particularly in cases of meter replacements, there have been complaints of high bills from some customers. While the issues raised give cause for concern, it should be recognised that high electricity bills could result from a multiplicity of factors, and as such, the billing complaints raised may not necessarily be driven by the installation of the new advanced meters.

Notwithstanding, in light of the level of customer complaints received by the Office of Utilities Regulation (OUR), as well as related complaints raised in the media, the OUR engaged JPS on the matter. JPS proceeded to conduct an investigation into complaints related to smart meter installations. The OUR's review of JPS' investigation report, found that there were significant limitations in the company's investigation approach, and consequently, the results and findings were not considered to be conclusive.

Given the circumstances, this investigation seeks to ascertain the integrity and accuracy of the meters in question, as well as to determine if there is any relationship between the reported billing/metering anomalies and the newly installed meters.

2.3 HISTORICAL REFERENCES

Prior to this investigation, assessments had been conducted to uncover the existence of any direct links between large-scale meter replacement/upgrade activities and increases in customer complaints due to increased bills. These included:

A. The OUR's Report: "Investigation of the Jamaica Public Service Company Ltd (JPS) Billing and Metering System for Electricity Consumption" dated 2011 October; and
B. JPS' Review of High Consumption Complaints Involving Advanced Electricity Meter Installations done in 2019.

A summary of the approaches taken and the findings are provided below.

2.3.1 OUR'S 2011 INVESTIGATION OF JPS BILLING AND METERING SYSTEM

This exercise was undertaken by a team led by an Independent Investigator – Mr. J Paul Morgan, who was appointed by the Office during 2011 August to investigate JPS' billing, meter replacement, meter inspections and audit, and meter testing practices and procedures. The investigation had its genesis in consumer concerns and reaction to the introduction of the electronic digital meters to replace the electromechanical meters that had been in use for decades.

While this investigation focused on a number of issues, included, as one of its objectives was the following:

- "Assess the legitimacy of the high consumption billing complaints as a consequence of the replacement of old (electro-mechanical) meters with new "digital" meters using appropriate sampling techniques."

This objective, in particular, is largely similar to the objective of this report, with the major difference being that the new meters being deployed in large quantities are classified as Advanced Meters, with two-way communication capabilities, instead of digital meters referenced in the 2011 investigation.

The findings from the 2011 investigation, with respect to the above objective, indicated that approximately 23% of customers who had an electro-mechanical meter replaced with an electronic one would have experienced some change in consumption attributable to meter replacement, with about 18.84% experiencing a high increase in consumption (>30% increase).

The investigation report went on to indicate that the actual drivers behind consumption increases could not be precisely established, and could be due to reasons such as:

1. The old meter had begun to under-record and thus the customer was actually using more than was recorded.
2. The new meter was over-recording.
3. The customer previously had an illegitimate connection, which was rectified upon replacement.

As indicated by the report, the data analysis done in support of the investigation could not be used to determine which drivers, including those listed above, were behind the numerical results obtained. Instead, fieldwork would be required.

2.3.2 JPS' 2019 Review of Consumption Issues Linked to Advanced Meters Installations

In response to queries made by the OUR, JPS provided results from a review done on accounts, where meters were changed to smart meters between 2016 and 2019 June. According to JPS, the review focused on data relating to 2,978 accounts for which the company received complaints of high billing from customers. In conducting its review, the company focused on meter readings and consumption patterns for the 2,978 accounts for six (6) periods before the meter change, and six (6) periods after.

Findings from the review, as indicated by JPS, included the following:

- Approximately 49% of customers complaining of high billing experienced an increase in their bills in the range of 1-70% above their normal average.
- Approximately 17% saw an increase in excess of 70%, post smart meter installation.
- Approximately 34% of the account holders that made a complaint actually saw a reduction in their bills. In 92 instances, the reduction after the meter changes was in excess of 50%.

An observed limitation of JPS' review is that seasonality in consumption patterns was not accounted for, as the analysis did not compare consumption for like-months in determining consumption change (e.g. 2017 January and 2018 January), to give a better indication of differentials in consumption measurements recorded before and after meter replacements.

Additionally, JPS indicated that it also conducted analysis into trends in complaints related to the smart meter project and observed that complaints tended to peak during periods of large scale meter change; and during traditional high consumption periods, such as summer months.

In conclusion, JPS indicated that, based on its review, no systemic trend to higher consumption reading due to the change-out to smart meters was identified.

2.4 Scope and Structure of Report

This report was compiled to provide information on the approach and outcomes of the OUR's investigation into any links between reported billing/metering anomalies and newly installed advanced utility meters.

This report is divided into six (6) sections, including this Introduction, and contains Appendices.

- Section 2: Provides details on the approach employed in conducting the investigation
- Section 3: Data Structure and Categorization
- Section 4: Assessment of electricity meters' performance
- Section 5: Correlations and Relationships
- Section 6: Discussion of results and findings
- Section 7: Conclusions
- Section 8: Outline of next steps and further work

3 METHODOLOGY

3.1 APPROACH AND SCOPE OF ACTIVITIES

To reiterate, the purpose of this investigation is to determine the extent to which the integrity and functionality of advanced utility meters may be linked to customer complaints that have been raised, subsequent to meter replacement. Given the exigencies involved, and the OUR's responsibility to inform the public on these matters, it was decided that an investigation of limited scope be undertaken to provide preliminary indications on the extent of consumption changes being experienced by customers after a meter change, and the possible causal factors for such changes. Essentially, the scope of the investigation predominantly involved customer accounts with meter replacements (i.e. existing meter replaced with advanced meters).

Notably, this investigation was largely driven by metering data and analysis, and as such, the results are highly dependent on the accuracy, completeness and usability of the data provided by the relevant utilities.

Given the relatively large number of advanced meters deployed by JPS since 2017, and the limited investigation timeline, the OUR decided to utilize a sample-based approach in conducting the necessary metering data analysis. From a project execution perspective, this approach would expedite the tasks related to data collection, preparation and analysis.

The main activities performed in completing the investigation entailed the following, which are delineated below:

A. Identification of Relevant Metering Data associated with meter replacements;
B. Requesting List of Accounts with Meter Replacements;
C. Selection of Representative Customer Account Sample from list of Accounts with Meter Replacements;
D. Review of Consumption Data related to Customer Account Sample;
E. Data Evaluation and Analysis; and
F. Presentation of Results and Findings.

3.2 METERING DATA REQUIREMENTS

To facilitate the investigation, information specific to the advanced revenue meter deployment programmes being implemented by JPS, over the period 2017 January to 2019 June ("the Investigation Period"), was identified and requested from the company.

3.2.1 METERING DATA COLLECTION

After discussing the purpose, objective and scope of the investigation with JPS, the OUR, by way of letter, dated 2019 December 3 (Refer to Appendix B – Copies of Correspondences Between OUR & Utilities), requested specific information applicable to all customer accounts for which existing revenue meters were replaced with advanced meter types during the investigation period. The information requested included:

a) The number of customer accounts with existing meter replacement;
b) The advanced meter type;
c) The advanced meter manufacturer's serial number;
d) The utility assigned meter number;
e) The advanced meter installation date;
f) The meter location/service address; and
g) The customer and premises number.

Data templates were issued to JPS to guide the compilation of the meter related data.

The data submitted by JPS is summarized in **Error! Reference source not found.** below:

Table 2.1: JPS Reported Existing Revenue Meter Replacements with Advanced Meters

Meter Replacements (Existing Meter Replaced by Advanced Meter): 2017 January – 2019 June			
UTILITY	**DATE SUBMITTED**	**POPULATION (Number of Accounts)**	**REMARKS**
JPS	2019 December 12	134,778	All requested data Items not included for some accounts.

3.3 ACCOUNT SAMPLE SELECTION

As shown in shown in Table 2.1, the population of customer accounts with replaced meters under investigation is 134,778, as reported by JPS. This was a relatively large population to study, which could be complex and time demanding, with only a marginal increase in accuracy of results. In recognition of this constraint, it was determined that an effective, expedient and practicable approach, was to select a representative sample for this population, from which conclusions could be drawn without any material deviation in accuracy. In selecting the appropriate sample, a number of factors were accounted for, including the desired statistical confidence level and confidence interval (margin of error).

3.3.1 DETERMINATION OF SAMPLE SIZE

With respect to this assessment, the sampling approach adopted by the OUR took into account, among other things, the following conditions:

- The selected samples should at minimum, achieve a statistical confidence level of 95% in the results obtained, with a confidence interval of 5%; and
- The samples should be robust and representative of the existing environment/population under observation that is, encapsulating sufficient accounts/meters, reflecting varying characteristics such as customer class, meter type, installation locations, meter Lots, etc. to allow for comparisons across features to be made.
- A random approach was employed for sample selection. Some degree of stratification was done among features of the population, such as installation location, and the meter Type for the replaced meter. This was done to ensure reasonable representations, as well as to facilitate more detailed analysis beyond simply determining changes in average overall consumption, prior and subsequent to, the installation of an advanced utility revenue meter.

Estimation of Sample Size

Based on the above conditions, for the population of 134,778 accounts, about 384 customer accounts was the expected sample size for the electricity meter investigation. With simple approximation, a sample size of 400 accounts was established, for which consumption data prior and subsequent to meter change was requested from JPS.

Given the scope of the investigation, the selected account samples were integral to the assessment of consumption measurements and change patterns prior and subsequent to meter replacements. This was regarded as a critical step towards achieving the objectives of the investigation.

3.3.2 CONSUMPTION DATA

Following the sample selection process, the OUR requested consumption related data associated with the sample of 400 accounts, from JPS in 2019 December. The information requested included:

- Monthly consumption data for at least twelve (12) months prior to meter change and six (6) months subsequent to meter change, for all accounts selected. This was necessary to ensure like-month consumption comparison for any six-month period after the advanced meter installation; and
- Meter information for the selected accounts, including meter type, installation date and manufacturer serial number for the old meter that was replaced.

JPS' response to the OUR's metering information request was received on 2020 January 21. Copies of the relevant correspondences are included in

Appendix B – Copies of Correspondences Between OUR & Utilities of this report.

3.4 DATA REVIEW

Prior to performing the assessments, the meter/accounts datasets submitted by JPS were initially reviewed for accuracy, consistency and completeness. This was considered necessary to ensure that the results and outcomes were reasonably representative.

This data review process involved the following steps:

1. Each record in the account sample datasets were examined to determine whether the requested information, including consumption records, for the replaced revenue meter ("Old Meter") was included. Records that did not provide information associated with the Old Meter and restricted comparative analysis, were removed from the dataset, and therefore not used.
2. Months with missing consumption records and consumption of zero units were identified, and excluded from the dataset to limit the effect of data biases in the analysis.
3. Inconsistencies among identifiers, names of meter manufacturers, or parishes, etc. were corrected.

After the initial data review, the refined dataset was then used to conduct the analysis.

A description of metering datasets, initial observations made and data preparation work performed are presented below.

3.4.1 INITIAL OBSERVATIONS

The OUR's review of the dataset submitted by JPS for the selected samples of 400 accounts revealed information gaps involving the number of meter replacements and the number of consumption readings. These observations are summarized in **Error! Reference source not found.** below.

Table 2.2: OUR's Observations from Consumption Dataset

JPS CUSTOMER CONSUMPTION DATA	
Component	**Total**
Number of Accounts (Sample Size)	400
Number of Accounts with information on Replaced Meters	335
Number of Accounts with sufficient data records to support reliable analysis	308

To expound, some data records did not have the key information on replaced meters, such as meter identification information and consumption data prior to meter replacement. In some cases, this deficiency was compounded either by incomplete and insufficient consumption data records, prior or subsequent to meter replacement.

3.4.2 PREPARATION OF DATA FOR ASSESSMENT

Based on the identified data issues, it was not considered prudent to include accounts with unsuitable data records in the assessment. Therefore, with some level of data screening and alteration, usable records that allowed for reasonable comparison were retained and used for the assessment.

The information pertaining to each record used for assessment included:

1. Customer and Premises number
2. Rate Class
3. Address
4. New Meter Number
5. New Meter Type
6. Lot Identification for New Meter
7. Installation Date for New Meter
8. Old Meter Number
9. Old Meter Type
10. Age of Old Meter (in years)
11. Average Percentage Change in Consumption After Meter Replacement

With respect to Lot identification for new meters, this was done using OUR records for meter Lots which were subject to Acceptance Testing under the MTAOP, since its promulgation in 2017 October. For meters that were tested/installed prior to the promulgation of the MTAOP, pseudo Lots were defined based on meter type and installation date.

3.4.2.1 Electricity Meter Data

A total of 308 accounts were identified with acceptable data records to facilitate the assessment, which was designated the "Revised Sample". While this sample size is approximately 77% of the original sample of 400 accounts, it is still considered to be largely representative and in alignment with the sample selection principles outlined above.

4 DATA STRUCTURE AND CATEGORIZATION

4.1 ELECTRICITY METERING DATA ORIENTATION

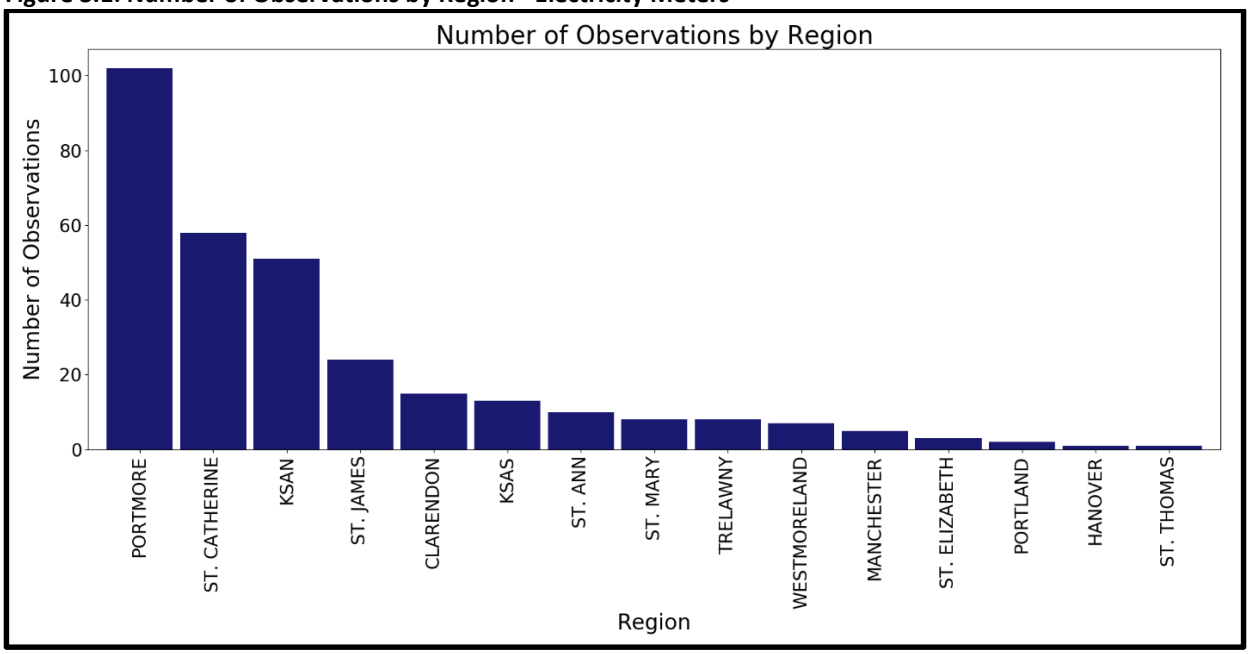
Following the data normalization process, the data in the electricity accounts sample was evaluated and categorized as shown in Table 3.1.

Table 3.1: Categorization of Electricity Accounts Sample

Electricity Accounts Sample Data			
Category	**Highest Proportion**	**Lowest Proportion**	**Remarks**
Service Area	Portmore	St. Thomas	Apparently due to rollout sequence
Rate Class	Rate 10	Rate 40	Expected due to customer base allocation
Old Meter Type	ITRON C1S	GE 210+C_1S	
New Meter Type	ACLARA I210+C_2S	ACLARA_KV2C+9S	Expected due to Rate Class distribution
New Meter Lot ID	MTAOP Second Lot		Influenced by lot size (20,159 meters) & approval date

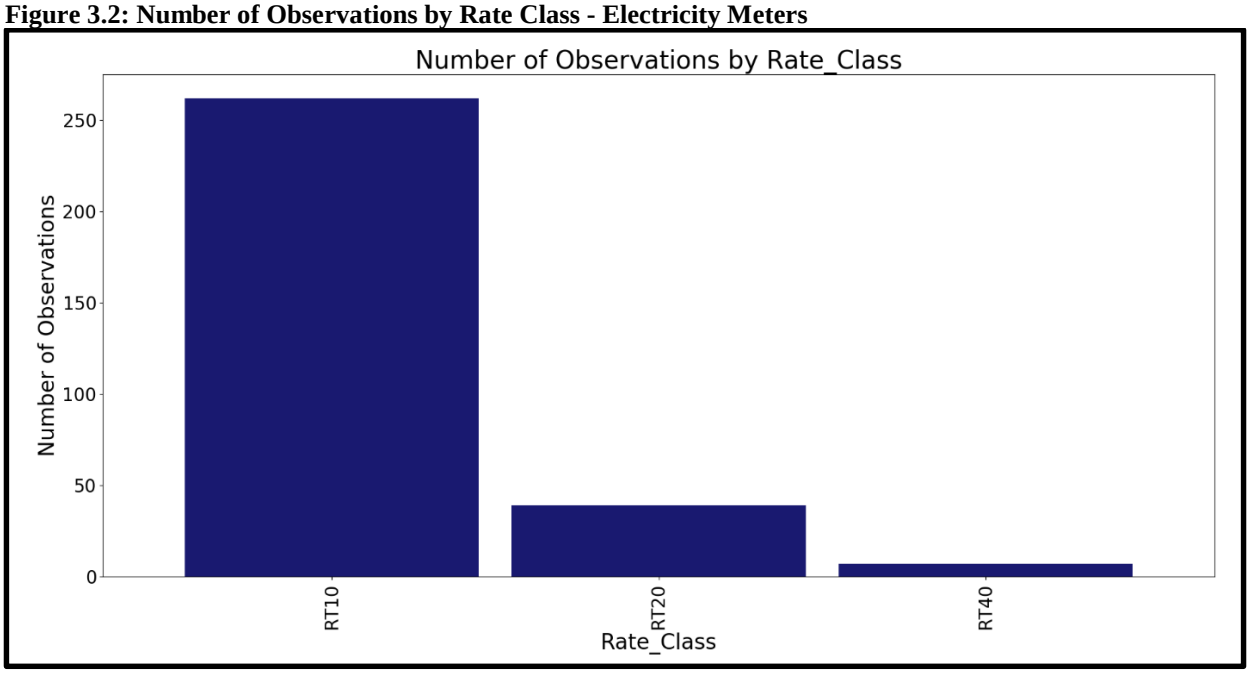
Figure 3.1 to 3.5 below further illuminates the characteristics of the data sample, which were pertinent to the assessment:

Figure 3.1: Number of Observations by Region - Electricity Meters



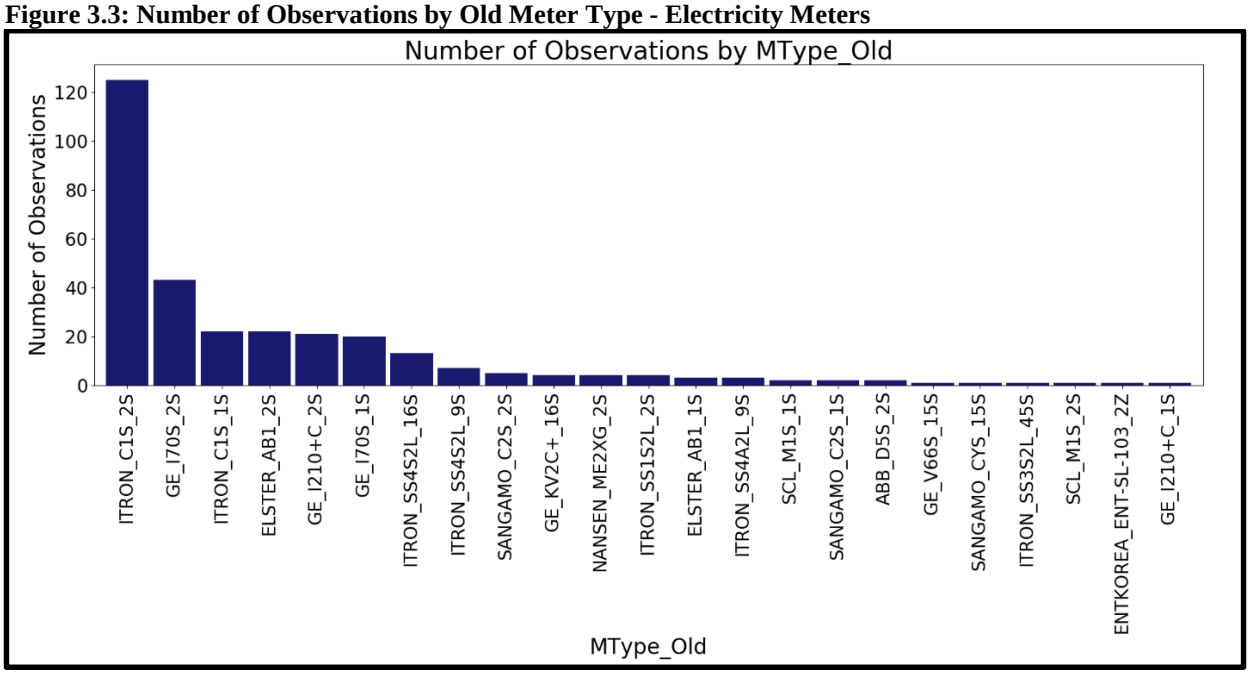
As shown, electricity revenue meters installed in St. Catherine accounted for the largest number of installations per Parish, by a considerable margin, over the period under investigation. The Portmore service area, in particular, accounted for the most installations. This meter replacement profile is not a surprise, as the initial rollout/ deployment of the advanced electricity meters was largely concentrated in the Parish of St. Catherine. This indication also appears to be consistent with the initial dataset provided by JPS for all meter replacements over the period 2017 January to 2019 June.

Figure 3.2: Number of Observations by Rate Class - Electricity Meters



As represented, the residential rate class (Rate 10), was the dominant feature of the distribution. This was not an anomaly and was generally expected, as Rate 10 customers accounted for almost 90% of JPS' customer base in 2019.

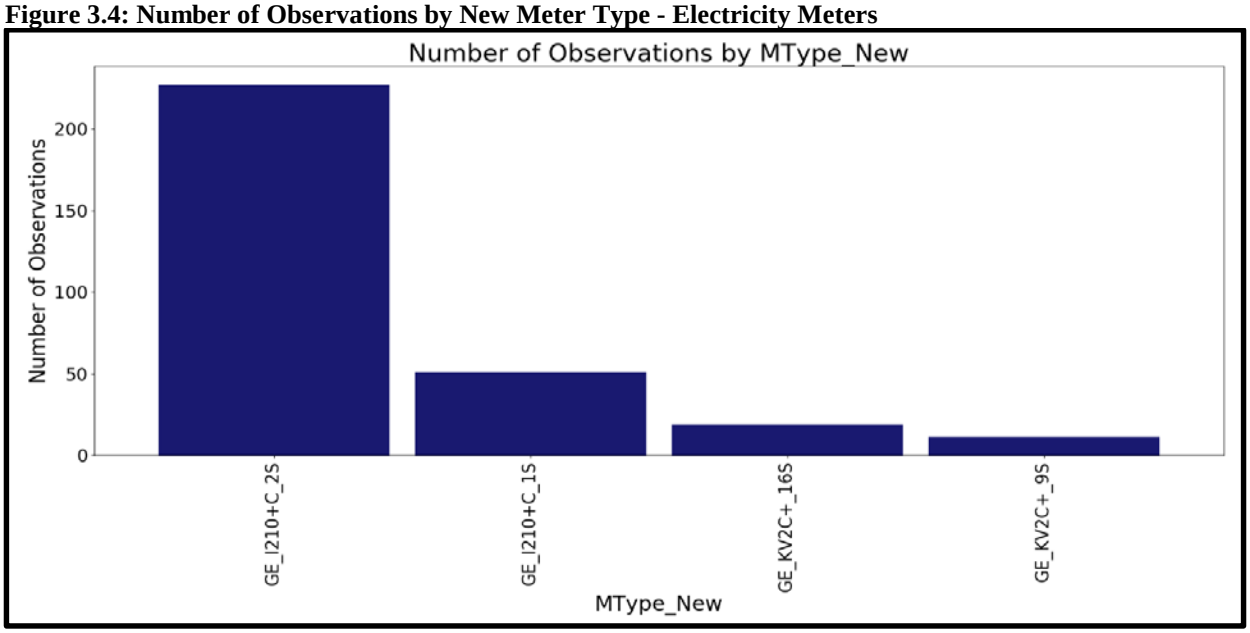
Figure 3.3: Number of Observations by Old Meter Type - Electricity Meters



The sample indicates that the Itron C1S Form 2S was the most frequently replaced meter Pattern (Type) over the period. As shown, twenty-two (22) other meter Patterns were also included among devices replaced with advanced meters. With respect to the Itron C1S Form 2S, this should be a relatively modern electricity

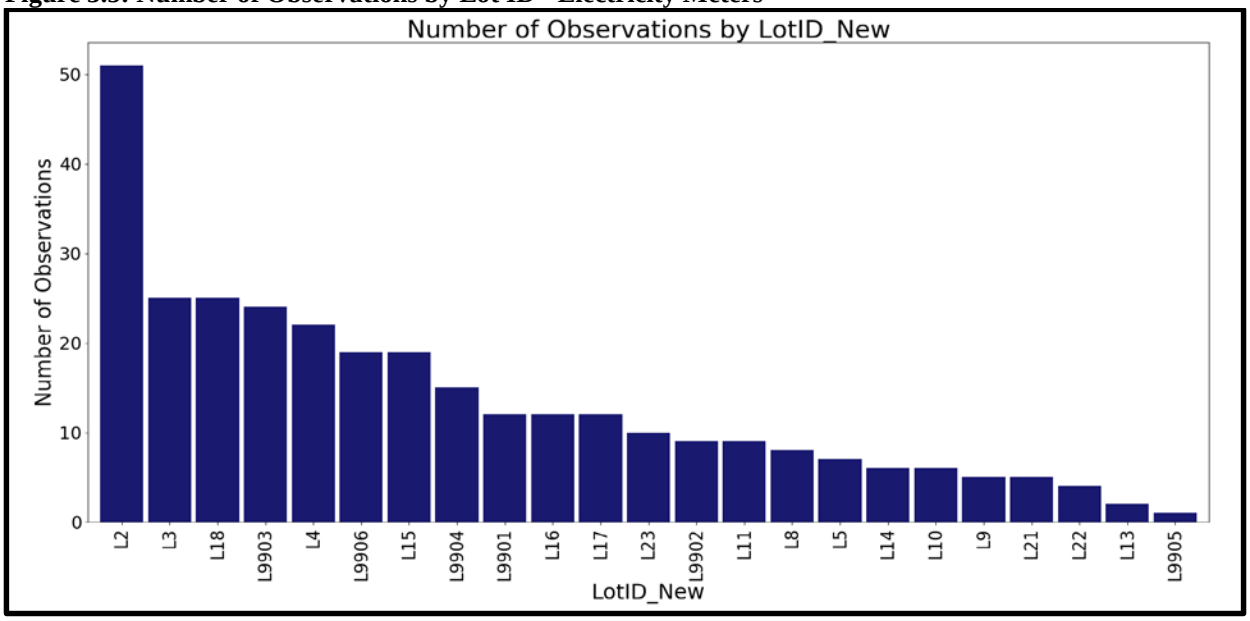
meter, and so, it is not clear as to why this appears to have been the most widely replaced meter. This will be further investigated.

Figure 3.4: Number of Observations by New Meter Type - Electricity Meters



Based on the sample, the new advanced meter Type most frequently used for meter replacements, by a considerable margin, is the Aclara (GE) I-210+C Form 2S. This is supported by Figure 3.4, which indicates that the meter Lot to which the highest number of devices in the sample belong, is Lot L2. Lot L2 consists of 20,159 Aclara (GE) I-210+C Form 2S meters which were granted Acceptance Approval by the OUR on 2018 March 28.

Figure 3.5: Number of Observations by Lot ID - Electricity Meters



Note: Further details on each meter Lot identified, can be found in Appendix D – Referenced Meter Lot Acceptance Testing Details. *Also, Lot IDs beginning with "L99" comprise of meters that were tested/installed prior to the promulgation of the MTAOP.*

5 ASSESSMENT OF ELECTRICITY METER PERFORMANCE

5.1 INPUTS AND ASSUMPTIONS

The assessment mainly focussed on changes in average recorded consumption (kWh) after meter replacement. As such, the key inputs in the analysis were electricity consumption readings (kWh) for like months prior and subsequent to meter replacement. Additionally, the following parameters were also derived from the meter/consumption data provided by JPS and used in the analysis:

- Age of Old Meter (in years) [*"MAge_Old"]*
- Average Percentage Change in Consumption After Meter Replacement [*"AvgCPC"*]

This data was then collated with the relevant information in the Revised Sample to constitute the database used for the assessment. The resulting dataset was then subject to statistical analysis, which is described in the sections below.

5.2 STATISTICAL ANALYSIS

5.2.1 ASSESSMENT OF REVISED SAMPLE

Based on statistical analyses carried out on the Revised Sample (308 accounts), the resulting summary statistics are presented in Table 4.1.

Table 4.1: Summary Statistics from Revised Sample

Summary Statistics - Revised Sample						
FEATURE	**COUNT**	**MIN**	**MAX**	**MEAN**	**MEDIAN**	**STD DEV**
Old Meter Age - *MAge_Old* (years)	308	0.17	38.67	9.49	7.29	7.72
Ave Consumption Change – *AvgCPC* (% X 100)	308	-0.74	142.94	**0.95**	**0.02**	8.73

For this analysis, the mean and median statistics are fundamental in assessing the robustness of the consumption data distribution, and to formulate deductions on the extent to which recorded consumption changes, following the transition from Old Meter to new meter, can be characterised. In terms of the statistical effect, a normal distribution for consumption change would usually be expected.

As shown in Table 4.1, the analysis generated a mean consumption change of **95%**, which appears to be excessive. However, there was wide variation between the mean and median statistic at **95% and 2%** respectively, suggesting a lack of symmetry and a departure from the normal distribution representation. Based on the observations, this outcome is indicative of significant skewness in the distribution, due to the presence of noticeably large outliers in the consumption data. This is illustrated in Figure 4.1 and Figure 4.2, which identify some of the major outliers.

Figure 4.1: Histogram of AvgCPC – Electricity Meters

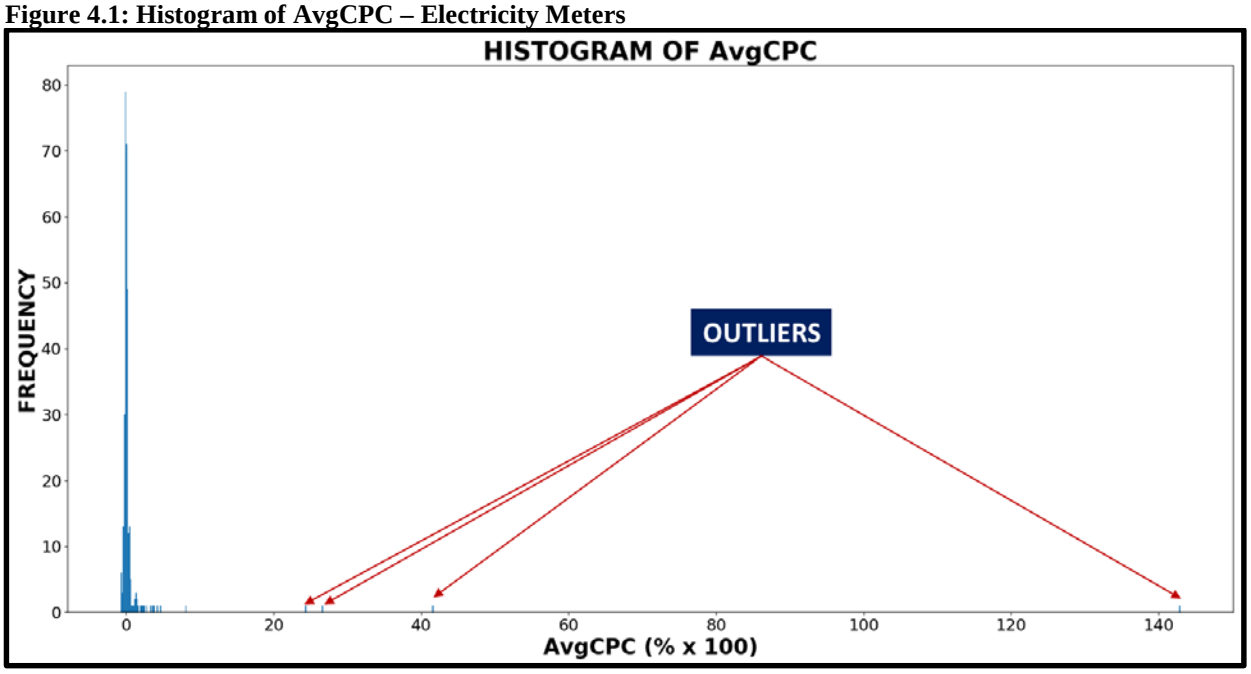
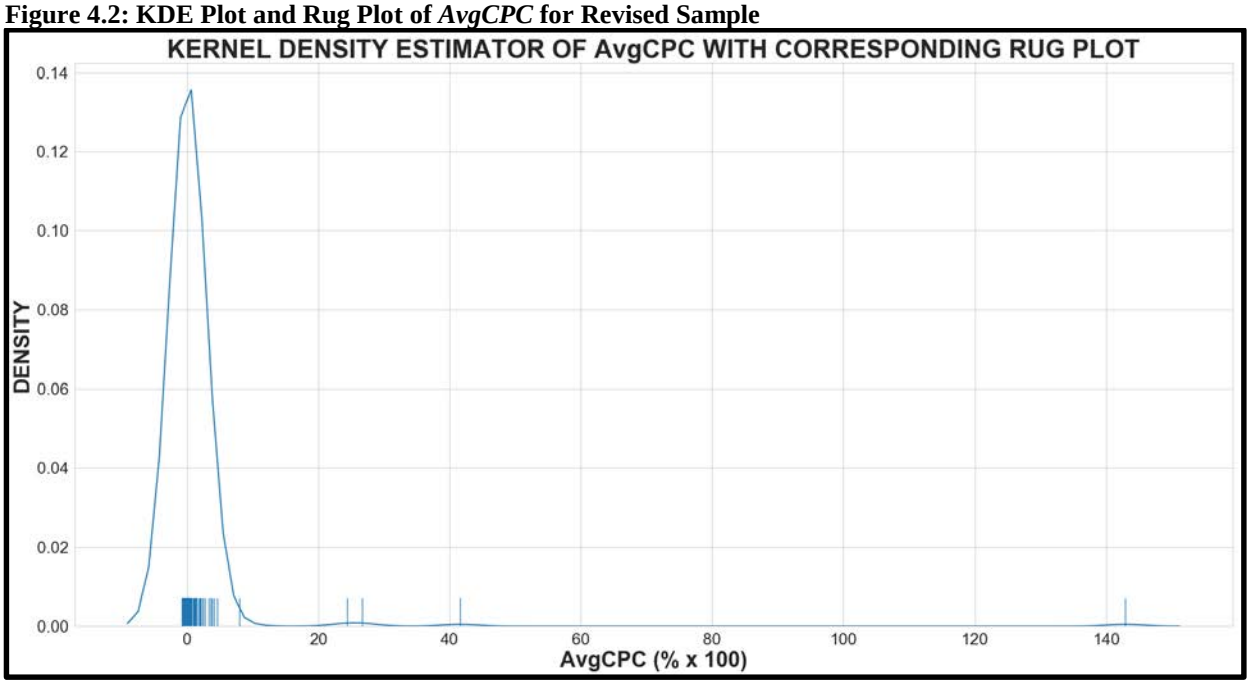


Figure 4.2 provides a clearer visualization of the indicated variation and profile of the distribution.

Figure 4.2: KDE Plot and Rug Plot of *AvgCPC* for Revised Sample



As shown, the data is highly right-skewed, with a number of very large outliers, but with the clear majority of observations being centred around zero. This indicates that separating outliers from the dataset, and treating them separately, would give indications that are more representative.

5.2.2 OUTLIERS

Based on the initial analysis, a total of twenty-four (24) accounts with outlier consumption data were identified, which were separately examined. Details of these accounts are provided in Table 4.2 below.

Table 4.2: Details of Electricity Accounts with Outlier Data

Electricity Accounts with Outlier Data								
CUST#-PREM#	REGION	MNUMBER_NEW	MTYPE_NEW	LOTID_NEW	INSTALLATION DATE	MTYPE_OLD	MAGE_OLD (Years)	AVGCPC (%)
996471-836533	ST. JAMES	2177680	GE_I210+C_2S	L9906	2018/10/20	ELSTER_AB1_2S	10.52	14,294
448043-451172	ST. JAMES	2182514	GE_I210+C_2S	L9903	2017/8/15	GE_I70S_2S	11.32	4,159
222922-224531	ST. CATHERINE	2328285	GE_I210+C_2S	L15	2018/11/12	SANGAMO_C2S_2S	27.48	2,667
1253537-177462	PORTMORE	2254305	GE_I210+C_1S	L3	2018/6/21	ITRON_C1S_1S	4.93	2,437
522007-527035	ST. MARY	2239992	GE_I210+C_2S	L4	2018/9/10	ITRON_C1S_2S	7.26	805
188254-849320	ST. CATHERINE	2299196	GE_I210+C_2S	L16	2018/11/21	ELSTER_AB1_2S	10.00	466
1069776-242104	PORTMORE	2235486	GE_I210+C_2S	L4	2018/6/22	ITRON_C1S_2S	7.02	415
809768-714411	HANOVER	2189348	GE_I210+C_2S	L9904	2017/10/23	GE_I210+C_2S	0.18	381
249047-250649	PORTMORE	2224700	GE_I210+C_2S	L2	2018/6/5	NANSEN_ME2XG_2S	15.96	357
610987-601761	PORTMORE	2247878	GE_I210+C_1S	L3	2018/7/10	ITRON_C1S_1S	6.39	336
225163-226767	ST. CATHERINE	2305318	GE_I210+C_2S	L10	2018/10/29	GE_I70S_2S	29.40	273
904371-789691	KSAN	2329123	GE_I210+C_2S	L15	2018/11/21	GE_I70S_2S	12.50	243
946062-821482	PORTMORE	2305726	GE_I210+C_2S	L17	2018/11/28	ELSTER_AB1_2S	11.36	239
865484-667548	PORTMORE	2218218	GE_I210+C_2S	L2	2018/4/24	ELSTER_AB1_2S	9.26	218
1285128-429583	PORTMORE	2233181	GE_I210+C_2S	L4	2018/6/26	ITRON_C1S_2S	0.80	205
649436-633301	PORTMORE	2210506	GE_I210+C_2S	L2	2018/4/3	NANSEN_ME2XG_2S	17.28	196
237340-238893	CLARENDON	2330898	GE_I210+C_2S	L15	2018/11/10	GE_I70S_2S	22.11	169
256763-258432	PORTMORE	2251196	GE_I210+C_1S	L3	2018/6/5	GE_I70S_1S	22.11	146
257038-258707	PORTMORE	2250217	GE_I210+C_1S	L3	2018/6/6	ITRON_C1S_2S	6.00	143
154386-826351	ST. ELIZABETH	2169018	GE_I210+C_2S	L9901	2017/7/23	ELSTER_AB1_2S	9.73	141
1345817-772441	ST. CATHERINE	2308402	GE_I210+C_2S	L17	2019/5/1	GE_I70S_2S	13.62	134
1055624-433604	ST. ANN	2235744	GE_I210+C_2S	L4	2018/8/14	ITRON_C1S_2S	0.74	131
609426-600415	PORTMORE	2221060	GE_I210+C_2S	L2	2018/5/4	ITRON_C1S_2S	13.79	124
1055915-898225	PORTMORE	2230456	GE_I210+C_2S	L2	2018/6/10	ITRON_C1S_2S	7.24	117

The outlier data is also represented graphically in Figure 4.3 and Figure 4.4 below.

Figure 4.3: Outlier Data by Categories

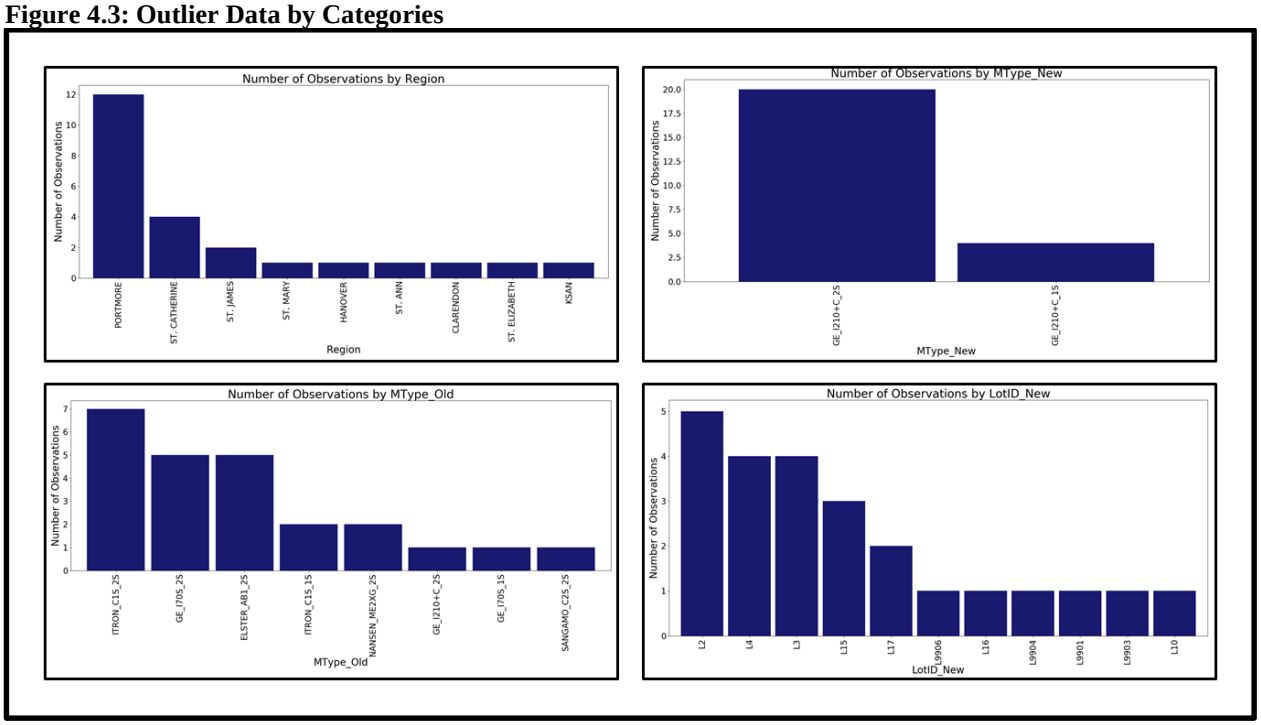
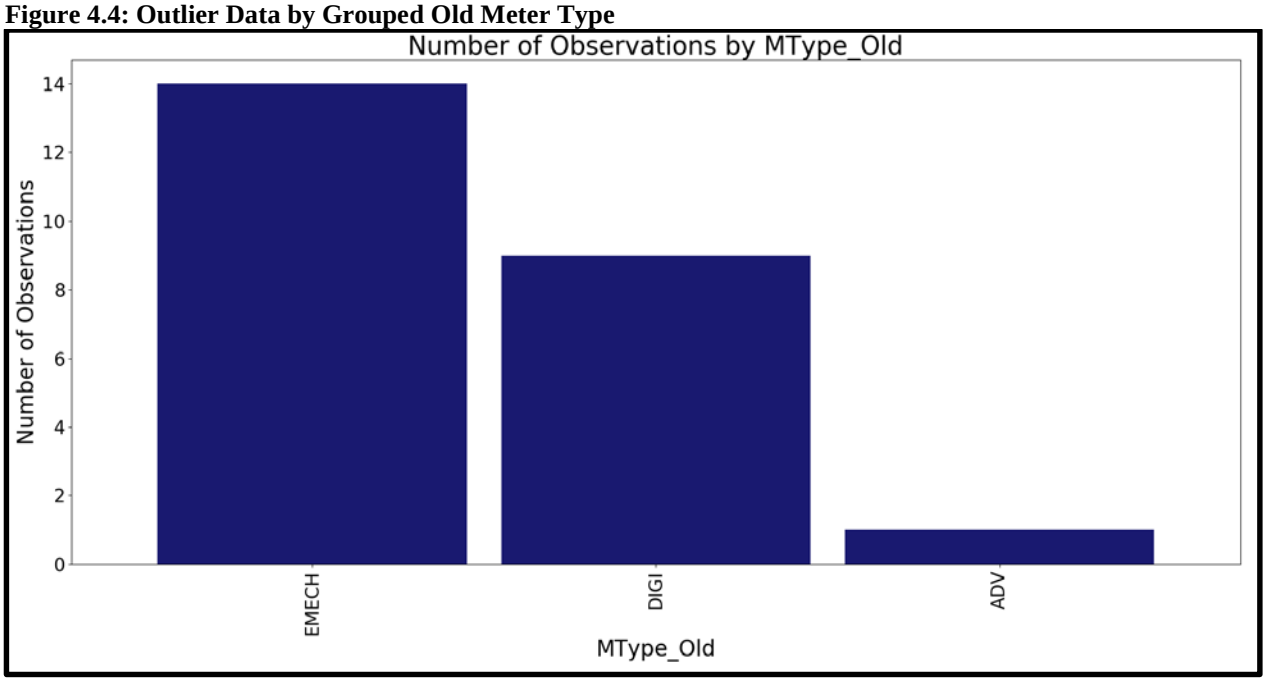


Figure 4.4: Outlier Data by Grouped Old Meter Type



5.2.2.1 Observations

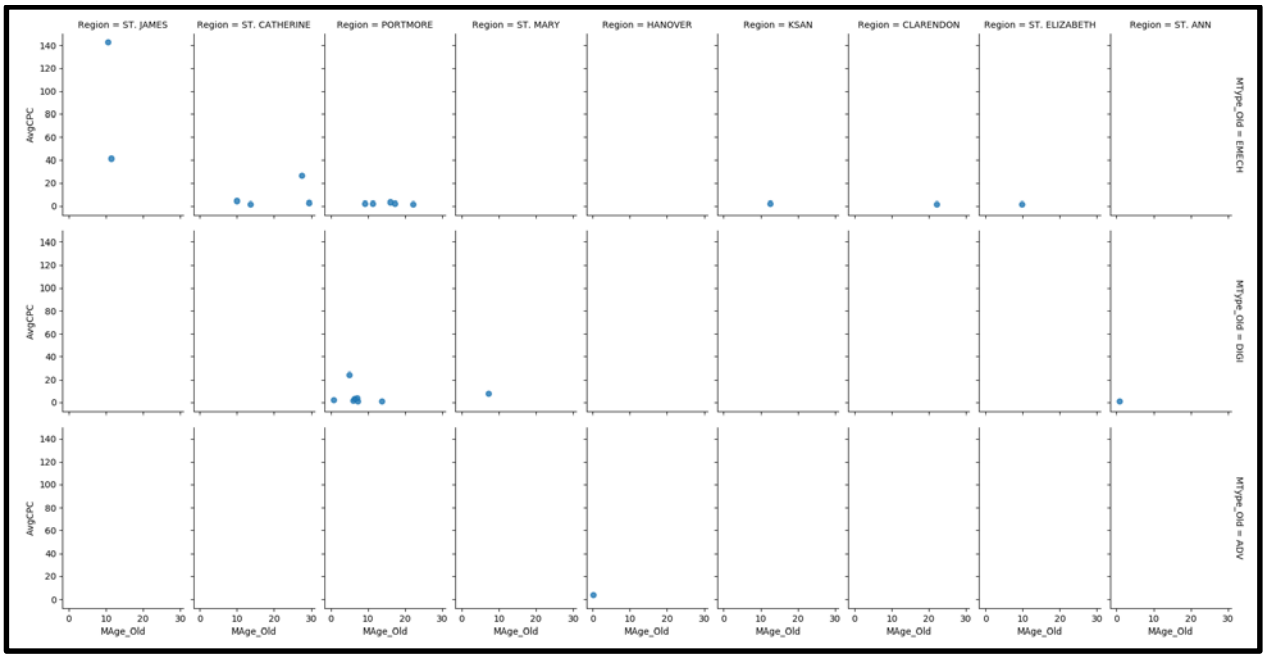
1) All of the twenty-four (24) outliers identified were linked to Rate 10 accounts.
2) Twelve (12) of the outliers (50%) were found to be associated with accounts within the Portmore service area (eight located in Gregory Park), with a further four (4) associated with accounts located

in other parts of the parish of St. Catherine. These have been subjected to further investigation and discussions with JPS.

3) Accounts in St. James were associated with two (2) outliers. No region located outside St. James and St. Catherine was associated with more than a single outlier.
4) Eight (8) different Old Meter Types (replaced meters) were associated with identified outliers. Seven (7) of the replaced meters were the Itron C1S Form 2S meter Type.
5) Old Meter Types featuring the most were those of electromechanical design, which were linked to fourteen (14) of the outliers. This is an issue that will need to be further investigated, on the basis that these devices have reached the point of obsolescence, and should not be in service. Additionally, the useful asset lives for meters set out under Schedule 4 of the Electricity Licence, 2016, would have resulted in these meters being removed from the fixed asset register and asset base.

Further characteristics of the outlier data can be revealed by examining relationships between a number of features of the dataset using conditioned plots. Figure 4.5 below explores relationships between the average consumption change ("*AvgCPC*"), the age of the Old Meter ("*MAge_Old*"), the region where the account is located ("*Region*") and the grouping of the Old Meter Type ("*MType_Old*").

Figure 4.5: Relationships Between "*AvgCPC*", "*MAge_Old*", "*Region*" and Grouped "*MType_Old*" for Outlier Data



As shown, the two (2) largest outliers are both associated with accounts with addresses in St. James. However, the specific communities are a number of kilometres apart, so it is not clear whether there is any common connection.

5.3 ASSESSMENT OF ADJUSTED SAMPLE – OUTLIERS REMOVED

To limit the influence of the outliers, the 308 sample was trimmed to 284 accounts ("Adjusted Sample"). Statistical analyses on the Adjusted Sample yielded the summary statistics presented in Table 4.3.

Table 4.3: Summary Statistics from Adjusted Sample – Outliers Removed

Summary Statistics - Adjusted Sample						
FEATURE	**COUNT**	**MIN**	**MAX**	**MEAN**	**MEDIAN**	**STD DEV**
Meter Age - *MAge_Old* (years)	284	0.17	38.67	9.32	7.11	7.70
Ave Consumption Change – *AvgCPC* (% X 100)	284	-0.74	0.99	**0.01**	**0.00**	0.25

As shown in Table 4.3, with the outliers removed, the analysis generated a mean consumption change of **1%,** and exhibiting convergence with the median statistic **0%** change. Intuitively, this outcome infers a symmetrical profile that is characteristic of a normal distribution, which depicts normal pattern of behaviour. This statistical representation is illustrated in Figure 4.6 and Figure 4.7 below.

Figure 4.6: Histogram of *AvgCPC* for Adjusted Sample - Outliers Removed

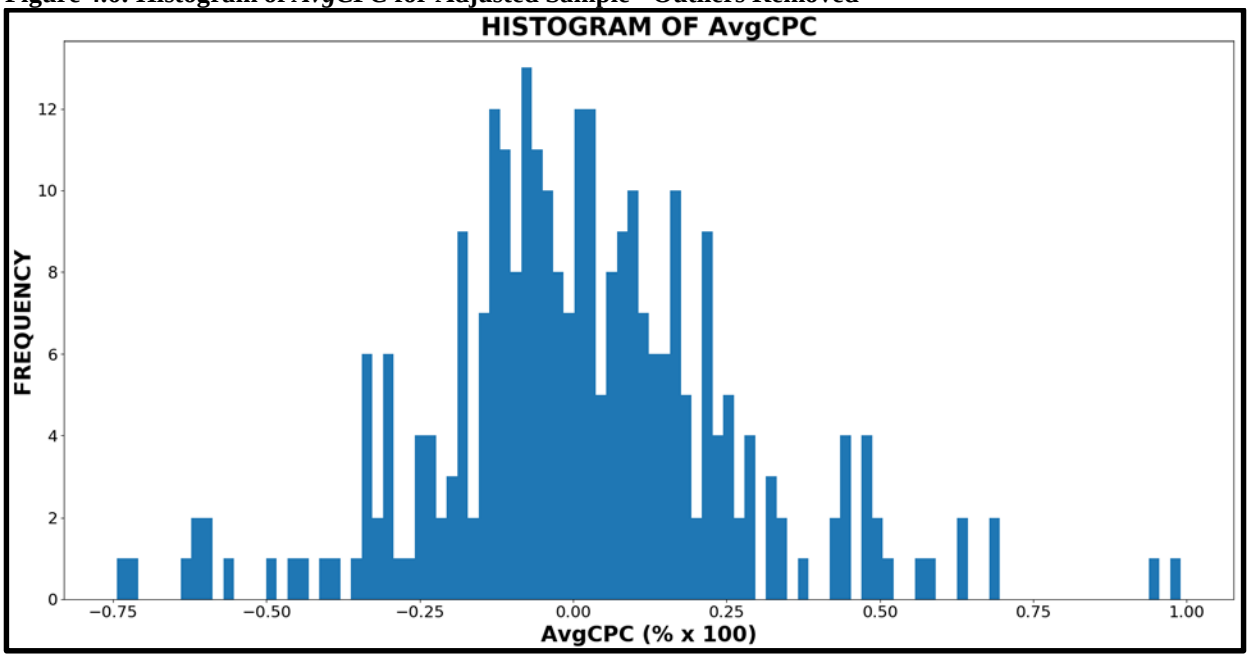
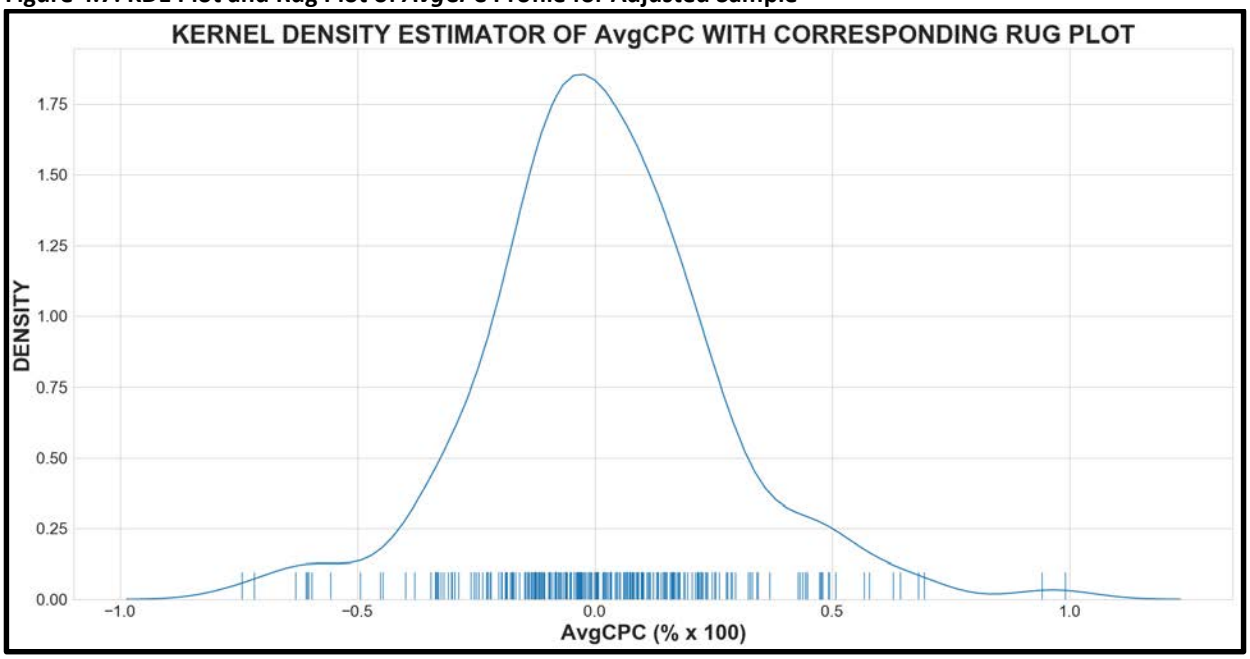


Figure 4.7: KDE Plot and Rug Plot of *AvgCPC* Profile for Adjusted Sample



Based on these results, it can be deduced that within the margins of error, the electricity consumption changes since commencement of the advanced meter deployment, is largely normal.

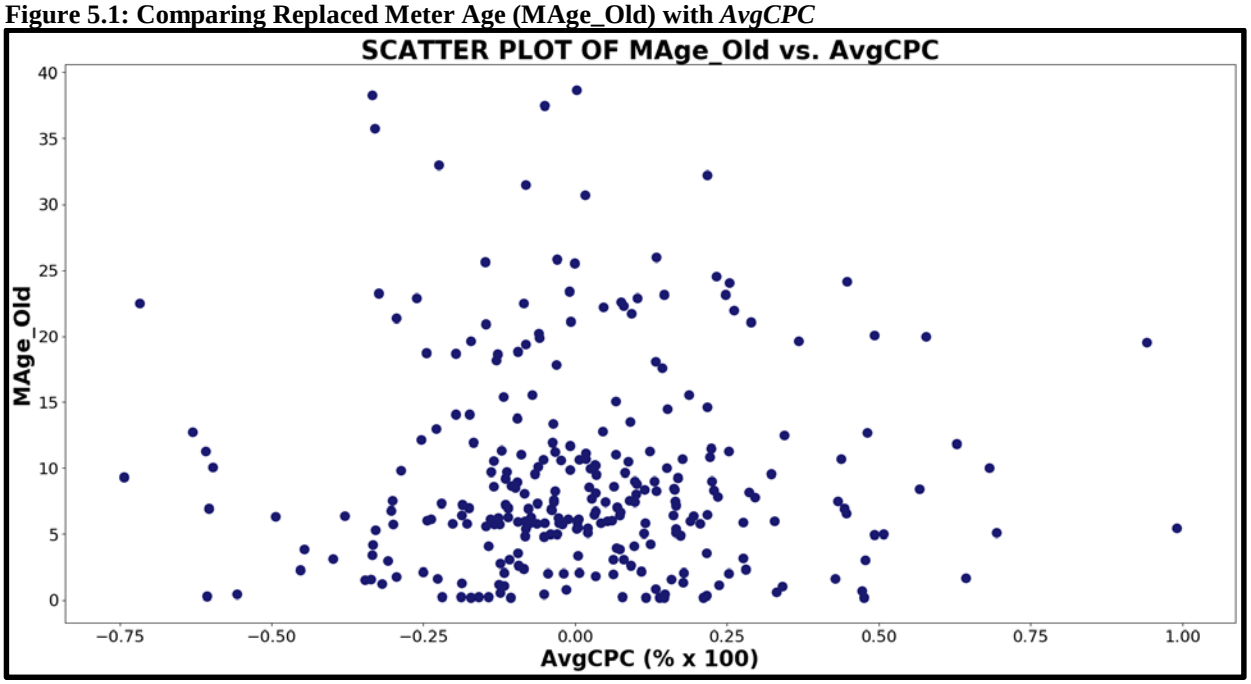
6 CORRELATION AND RELATIONSHIPS

In recognition of the wide statistical range derived from the *AvgCPC* data, a more detailed investigation may be necessary to provide greater understanding of some of the variations in consumption after a customer's meter is changed to an advanced meter Type. In that regard, it is characteristic of these analyses to test for correlations across categories/features in the dataset, to uncover any direct relationships, which may suggest causal factors for consumption change.

6.1 NUMERIC RELATIONSHIPS

The two numeric features in the dataset are *AvgCPC* and *MAge_Old*, indicating the average proportional change in recorded consumption and the age of the Old Meter (in years) when it was replaced. The scatter plot shown in Figure 5.1 below was generated for comparison of these two features.

Figure 5.1: Comparing Replaced Meter Age (MAge_Old) with *AvgCPC*



As illustrated in the scatter plot, there is no clear indication of any direct correlation between the average proportional change in recorded consumption and the age of the Old Meters in the Sample. However, one observation from Figure 5.1 is that 8 of the 284 records (2.82%) had Old Meter Types that were greater than 30 years old when replaced. While this may speak to a historic rather than current situation, further investigations/discussions with JPS may be necessary to determine the extent to which meters beyond their depreciable lives are still a part of the electricity system, with a view to having them replaced.

6.2 CATEGORICAL RELATIONSHIPS

Similar to the numeric features, an attempt was made to discover any possible relationship between categorical features and *AvgCPC*. The box plots shown in Figure 5.2 to Figure 5.6 below show some of the relationships explored.

Figure 5.2: Box Plots of *AvgCPC* by Region

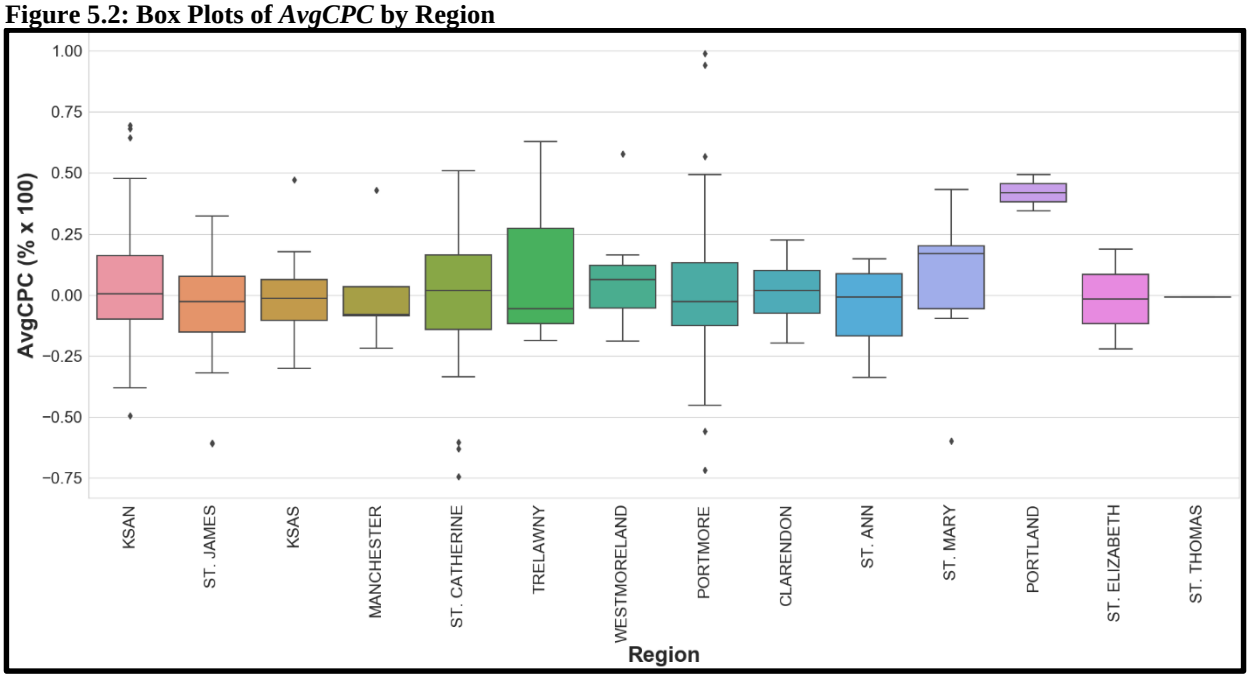


Figure 5.3: Box Plots of *AvgCPC* by Rate Class

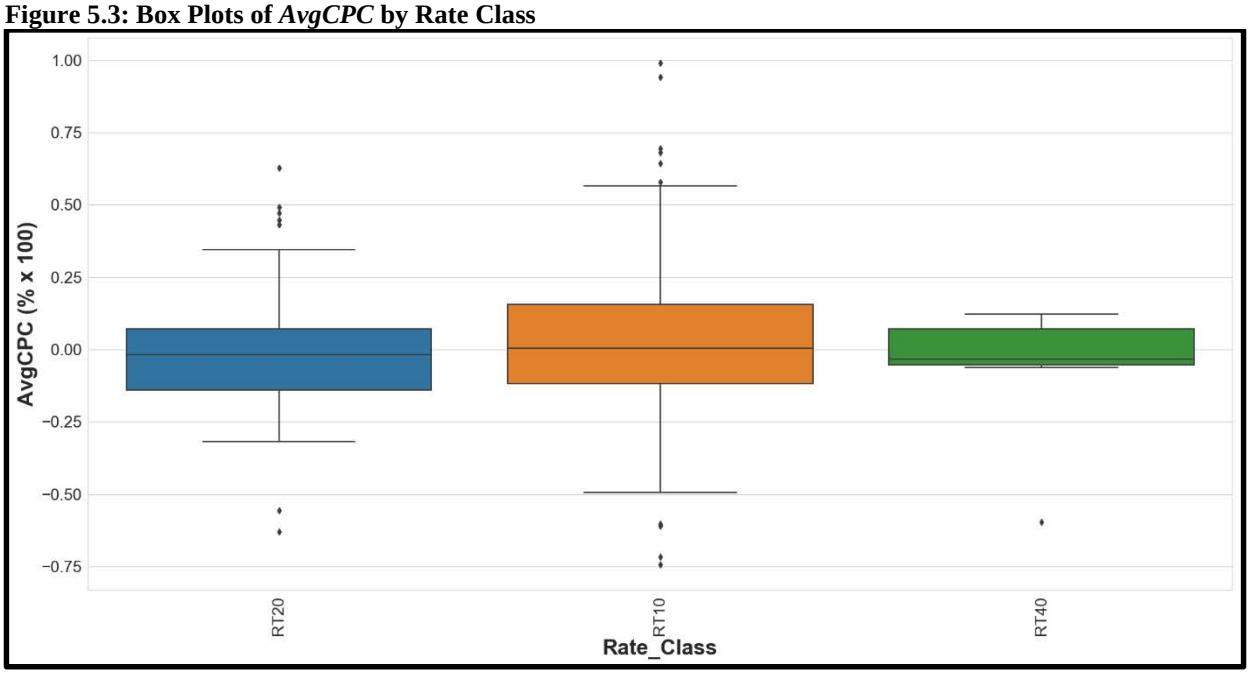


Figure 5.4: Box Plots of *AvgCPC* by New Meter Type (MType_New) - Electricity Meters

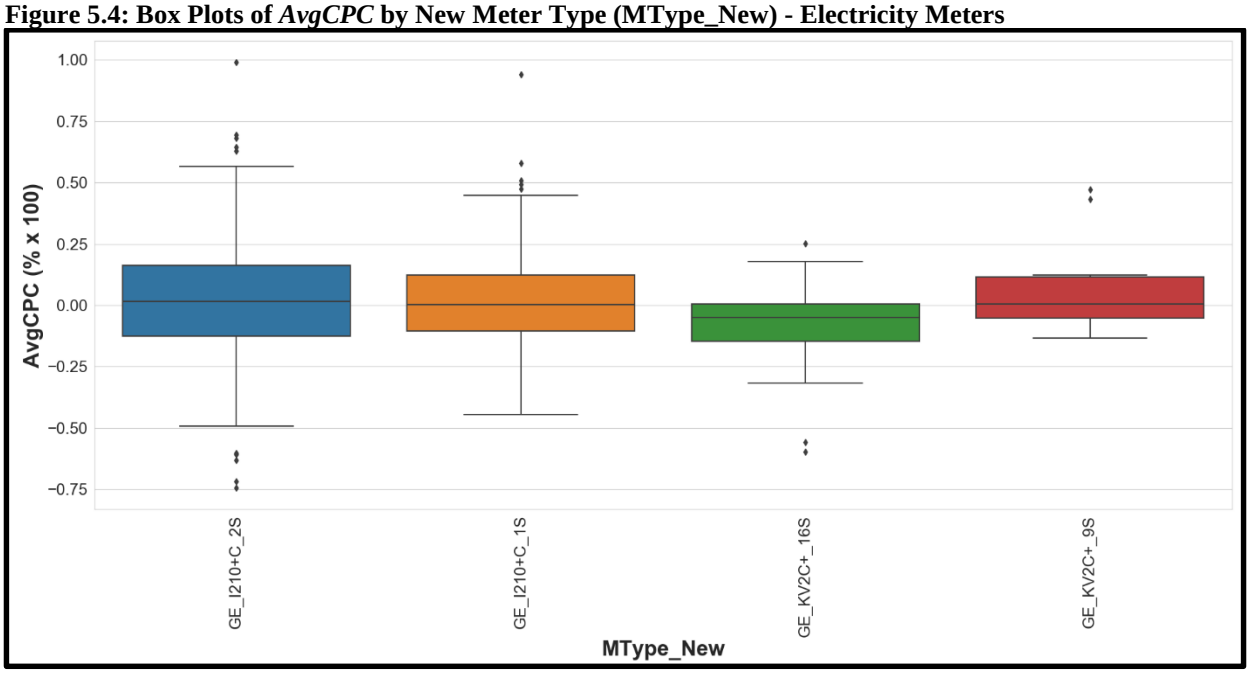


Figure 5.5: Box Plots of *AvgCPC* by New Meter Lot ID (LotID_New) - Electricity Meters

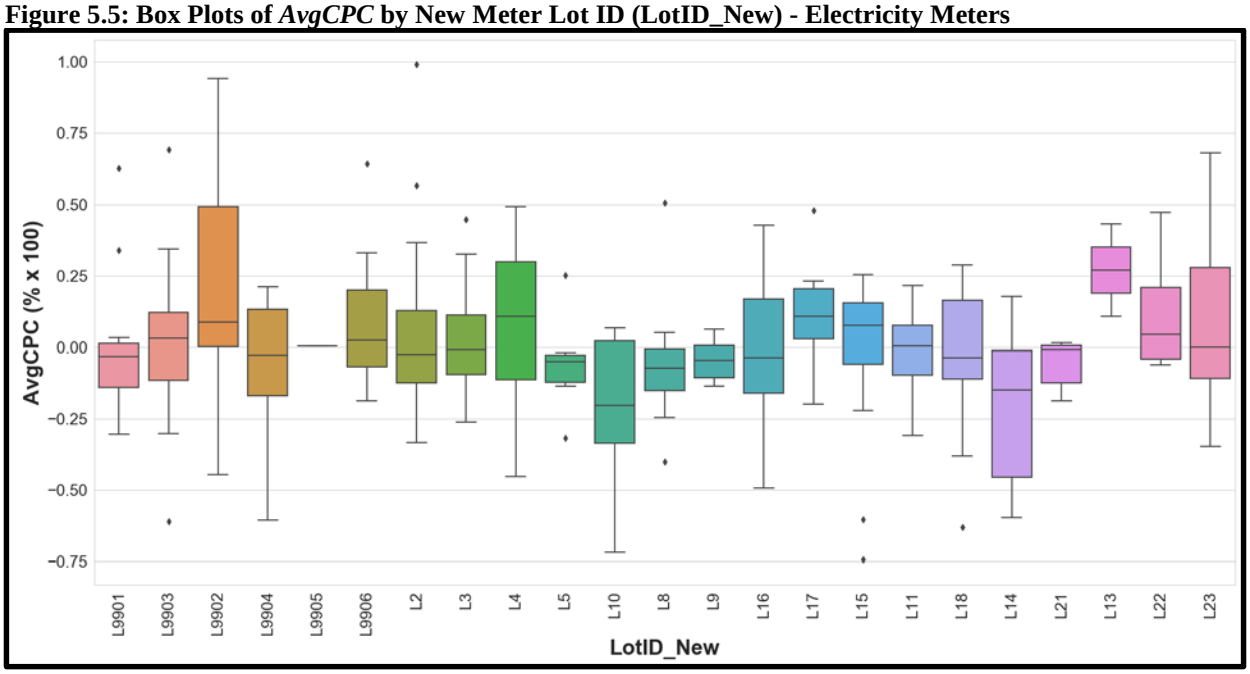
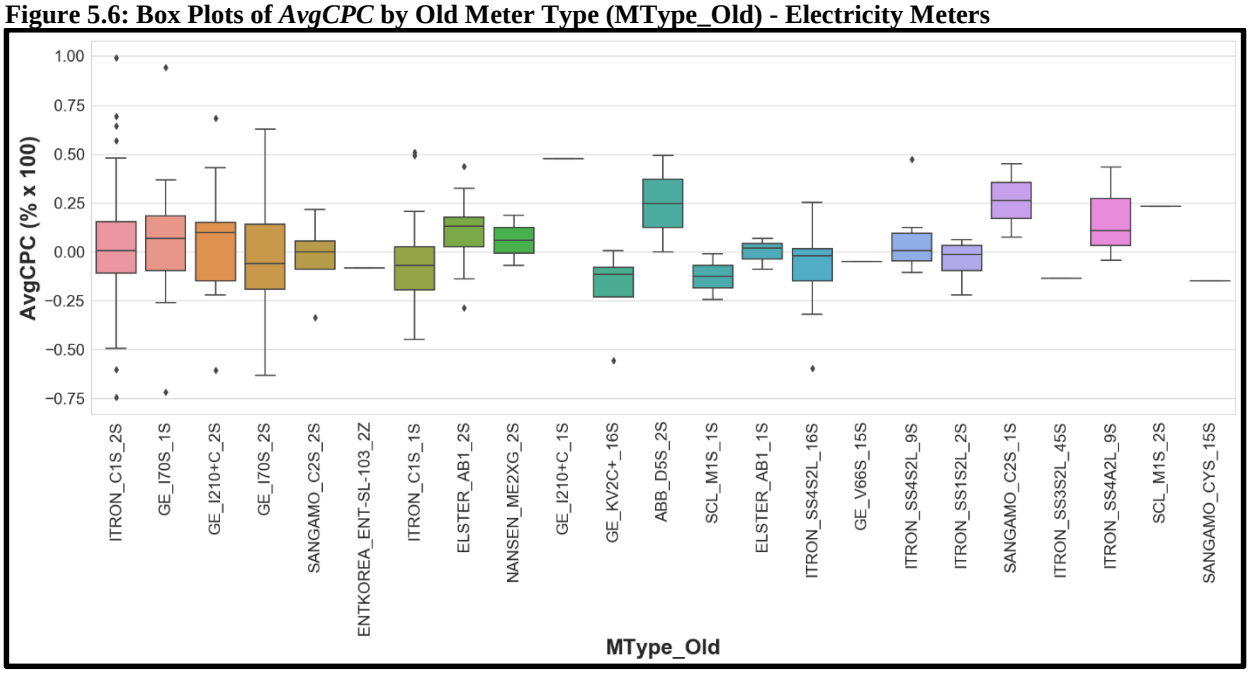


Figure 5.6: Box Plots of *AvgCPC* by Old Meter Type (MType_Old) - Electricity Meters



As exhibited in Figure 5.2 to Figure 5.6, there may be some relation between *AvgCPC* and categorical features of the dataset. The indications are as follows:

1) In terms of the behaviour across regions, it was shown that Portland and St. Mary had distinctly higher median values for *AvgCPC* compared to other regions. It is not immediately clear why these two north eastern parishes would be associated with this observation. Therefore, this may need further examination.
2) The various new meter types (*MType_New*) for residential service did not exhibit any distinctly high median values for *AvgCPC* indicating that any observed consumption changes may be independent of new meter Type. However, the Aclara (GE) kV2c+ Form 16S, primarily used for Rate 20 customers, was associated with accounts that exhibited a reduction in average consumption after meter replacement.
3) There is a relatively high variability in median *AvgCPC* values across new meter LotIDs. Lot 13, however, exhibits the highest median value for *AvgCPC*. On further examination however, this observation may be more attributable to the Old Meter Type that was replaced, rather than the meter Lot itself, as each device from this Lot that was a part of the Adjusted Sample replaced a meter that was an Itron SS4A2L Form 9S (an Old Meter Type associated with elevated changes in consumption, as exhibited in Figure 5.6).
4) When comparing median *AvgCPC* values across the Old Meter Types, the Sangamo C2S Form 1S, the ABB D5S Form 2S and the Elster AB1 Form 2S (all electromechanical meters), show distinctly high median values. This infers that there may be some correlation between *AvgCPC* and the age of Old Meter Types.

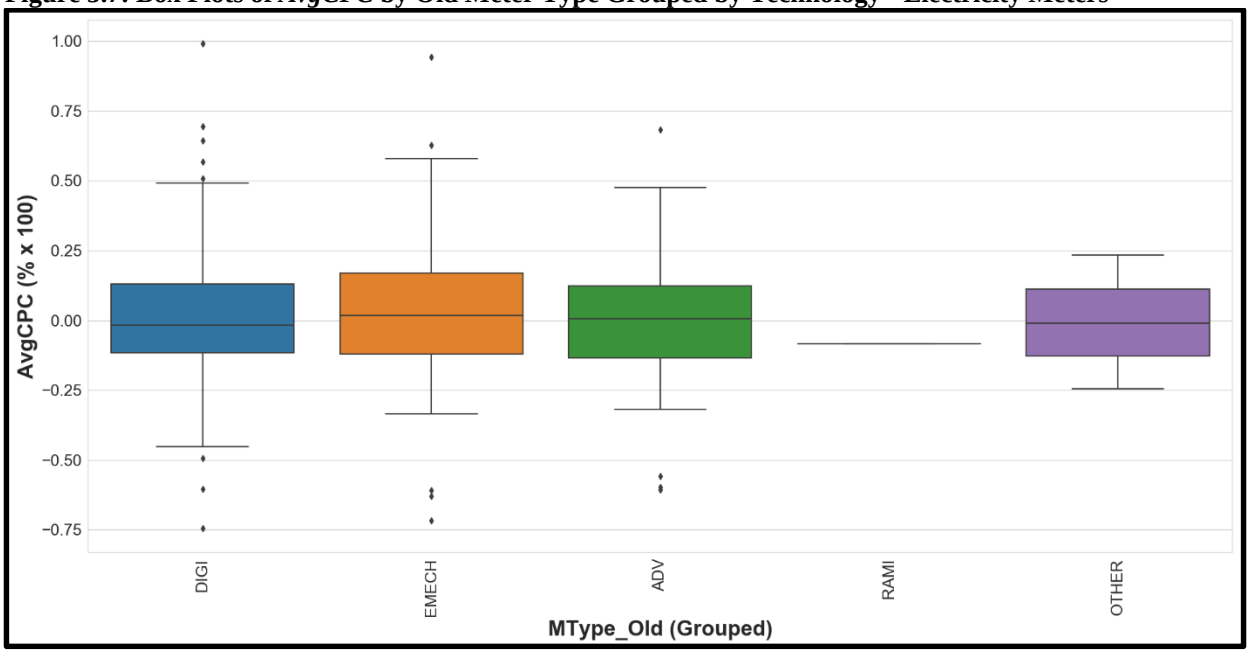
Based on indications from the Old Meter Types, they were grouped according to the following technology types, in order to investigate other possible relationships in the dataset:

a) Electromechanical ("*EMECH*")
b) Digital ("*DIGI*")

c) Advanced ("*ADV*")
d) Residential Advanced Metering Infrastructure ("RAMI")
e) Other

Box plots of *AvgCPC* by the specified meter type groupings were then made. These are shown in Figure 5.7 below.

Figure 5.7: Box Plots of *AvgCPC* by Old Meter Type Grouped by Technology - Electricity Meters



As represented above, the median *AvgCPC* appears to be slightly higher for accounts associated with Electromechanical Old Meter Types compared to other technology groupings.

Further investigations were made into these relationships, by way of creating conditioned plots showing relationships between *AvgCPC, Old Meter Age, Region* and *Old Meter Type* Groupings. These conditioned plots are shown in Appendix A – Additional Plots. These charts reveal that there is some degree of correlation between *AvgCPC* and the age of Old Electromechanical Meter Types. From these plots, it also appears that accounts with electromechanical meters tend to exhibit higher increases in consumption change; the older the meter is when replaced.

7 DISCUSSION

1. Based on the results of the analysis, it can be deduced that within the margins of error, the electricity consumption changes since commencement of the advanced meter deployment, largely exhibits a normal type distribution, where accounts experiencing consumption increases are fairly balanced with accounts experiencing reductions.

2. As indicated by the mean value for *AvgCPC*, the change in recorded electricity consumption after a customer's meter is replaced with an advanced meter is approximately a 1% increase, on average, after meter replacement. However, the change in consumption ranges from a minimum of -74% to a maximum of 99%, when outlier data is separated. Further investigations can therefore be carried out to determine if there are any relationships in the dataset that may help to explain the extent of the variation.

3. It is not unusual for large shifts in average consumption to occur for some accounts after large-scale meter replacements, due to the likelihood of progressive degradation in the accuracy and performance of older meter types over time. Another consideration could be the lack of a structured and systematic meter-testing regime in the initial phase of the smart meter deployments. Further, JPS also indicated that old meters that have been replaced were not tested upon replacement. As such, this resulted in the unavailability of critical information pertaining to meter accuracy and state of degradation, which would have enhanced the analysis.

4. Despite, the results, it is important to note that alterations in customer behaviour tend to have a direct impact on consumption patterns. However, this factor was not directly investigated, or accounted for in this analysis.

5. As indicated under section 5.2.2, twenty-four (24) outliers were identified on initial examination of the Revised Sample. A significant number of these identified outliers exhibited common features, and as such, a discussion was had with JPS, in order to investigate potential drivers for the commonalities. JPS conducted preliminary investigations into the 24 accounts, which consisted of desktop analysis, as well as field investigations for 17 of the 24 accounts. Resulting from JPS' investigations was a summary report, which was submitted to the OUR. This is currently under review. It should be noted however that field investigations were conducted during 2020 and thus these findings may not be representative of the situation when the meter was replaced.

6. As demonstrated under section 6, a number of possible relationships were examined between several of the features of each record in the Adjusted Sample, and the average change in consumption after meter change. While some features did not exhibit strong relationships with *AvgCPC*, it was observed that there might be some relationship between the region/parish in which the account is located and *AvgCPC*. More distinctly, it appears there is a relationship between the Old Meter Type and the change in consumption experienced after meter change. In particular, Old Meter Types, which are of electromechanical design, appear to have a significant relationship with above average consumption changes, after meter change.

7. While the evaluation of a larger sample size may not reveal significantly different results, with respect to global figures, such as mean or median change in consumption after a customer's meter is changed to an advanced meter, a larger sample may bring greater clarity to some relationships between account features, such as location (region/parish) and expected change in consumption after meter change. This could be considered in future assessments.

8 CONCLUSION

Taking into consideration, the results of this analysis, reports of previous meter assessments, and advanced meter test results (2017-2019), it can be concluded that the advanced meters seem to be functioning satisfactorily and are not necessarily the driver for excessive electricity consumption and billing complaints.

9 NEXT STEPS

1) Further investigation of the outliers. Report from JPS being reviewed.

2) Establishment of a framework to track meter installations after approvals in order to facilitate ongoing monitoring, similar future assessments and meter related audits.

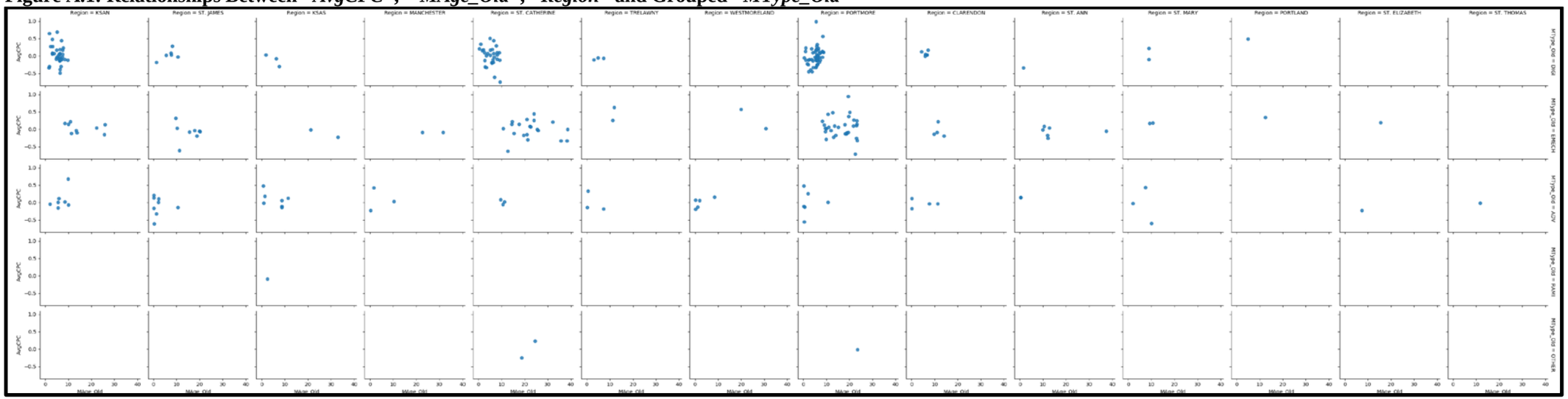
3) Collaborate with JPS to establish system to address the following:
   a) Testing of a sample of Old Meters shortly after replacement.
   b) Treatment of Old Meters after they are removed from service.

4) Subsequent investigation of meter replacements after 2019 June.

APPENDIX A – ADDITIONAL PLOTS

ADDITIONAL PLOTS RELATED TO ANALYSIS OF ELECTRICITY METER DATA

Figure A.1: Relationships Between "*AvgCPC*", "*MAge_Old*", "*Region*" and Grouped "*MType_Old*"

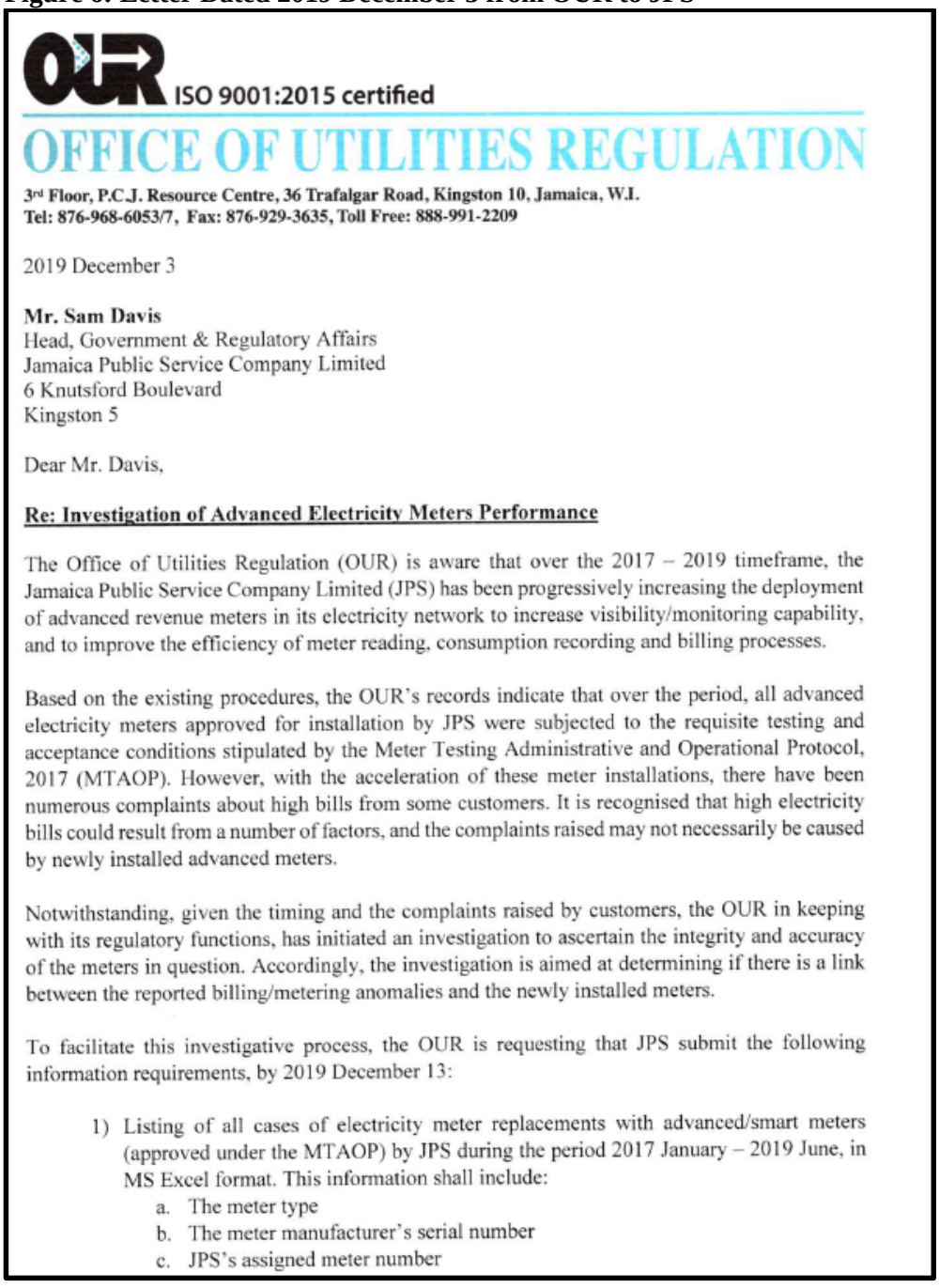


APPENDIX B – COPIES OF CORRESPONDENCES BETWEEN OUR & UTILITIES

CORRESPONDENCES BETWEEN OUR AND JPS

Figure 6 and Figure below show correspondence dated 2019 December 3 from OUR to JPS requesting information relating to the Advanced Utility Meters Investigation.

Figure 6: Letter Dated 2019 December 3 from OUR to JPS



ISO 9001:2015 certified

OFFICE OF UTILITIES REGULATION

3rd Floor, P.C.J. Resource Centre, 36 Trafalgar Road, Kingston 10, Jamaica, W.I.
Tel: 876-968-6053/7, Fax: 876-929-3635, Toll Free: 888-991-2209

2019 December 3

Mr. Sam Davis
Head, Government & Regulatory Affairs
Jamaica Public Service Company Limited
6 Knutsford Boulevard
Kingston 5

Dear Mr. Davis,

Re: Investigation of Advanced Electricity Meters Performance

The Office of Utilities Regulation (OUR) is aware that over the 2017 – 2019 timeframe, the Jamaica Public Service Company Limited (JPS) has been progressively increasing the deployment of advanced revenue meters in its electricity network to increase visibility/monitoring capability, and to improve the efficiency of meter reading, consumption recording and billing processes.

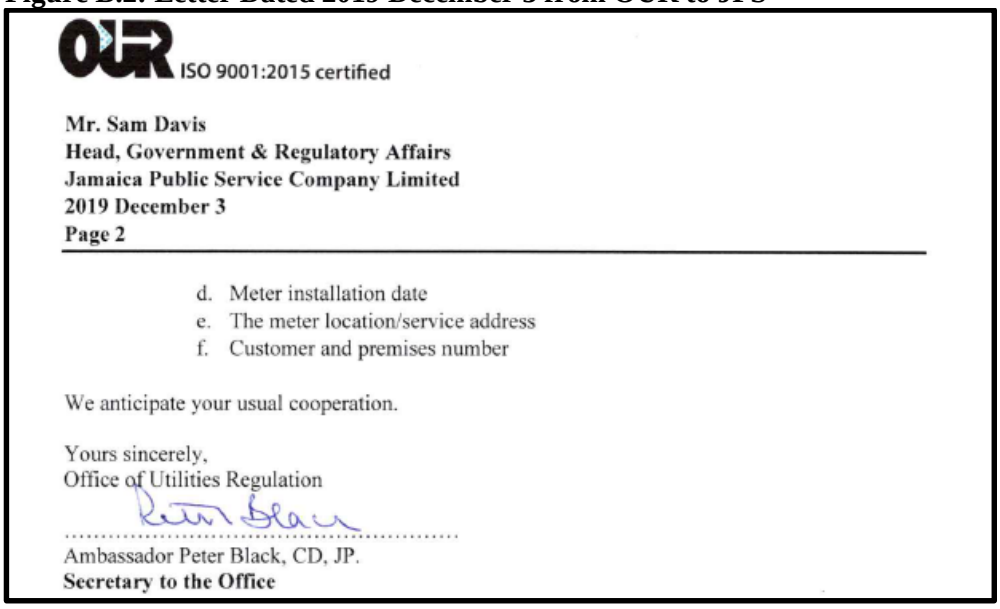
Based on the existing procedures, the OUR's records indicate that over the period, all advanced electricity meters approved for installation by JPS were subjected to the requisite testing and acceptance conditions stipulated by the Meter Testing Administrative and Operational Protocol, 2017 (MTAOP). However, with the acceleration of these meter installations, there have been numerous complaints about high bills from some customers. It is recognised that high electricity bills could result from a number of factors, and the complaints raised may not necessarily be caused by newly installed advanced meters.

Notwithstanding, given the timing and the complaints raised by customers, the OUR in keeping with its regulatory functions, has initiated an investigation to ascertain the integrity and accuracy of the meters in question. Accordingly, the investigation is aimed at determining if there is a link between the reported billing/metering anomalies and the newly installed meters.

To facilitate this investigative process, the OUR is requesting that JPS submit the following information requirements, by 2019 December 13:

1) Listing of all cases of electricity meter replacements with advanced/smart meters (approved under the MTAOP) by JPS during the period 2017 January – 2019 June, in MS Excel format. This information shall include:
    a. The meter type
    b. The meter manufacturer's serial number
    c. JPS's assigned meter number

Figure B.2: Letter Dated 2019 December 3 from OUR to JPS



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Mr. Sam Davis
Head, Government & Regulatory Affairs
Jamaica Public Service Company Limited
2019 December 3
Page 2

d. Meter installation date
e. The meter location/service address
f. Customer and premises number

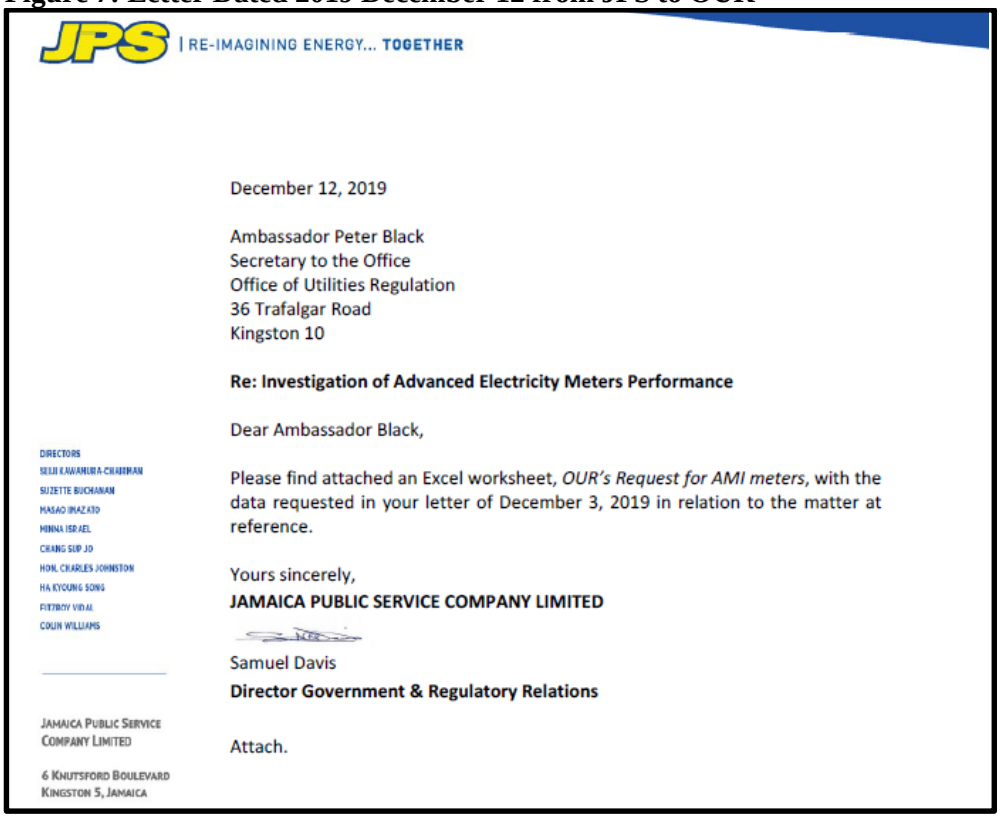
We anticipate your usual cooperation.

Yours sincerely,
Office of Utilities Regulation

.....
Ambassador Peter Black, CD, JP.
Secretary to the Office

Figure 7 below shows correspondence dated 2019 December 12 from OUR to JPS in response. Accompanying the letter shown was an MS Excel file containing the requested information on 134,778 JPS customer accounts.

Figure 7: Letter Dated 2019 December 12 from JPS to OUR



JPS | RE-IMAGINING ENERGY... TOGETHER

December 12, 2019

Ambassador Peter Black
Secretary to the Office
Office of Utilities Regulation
36 Trafalgar Road
Kingston 10

Re: Investigation of Advanced Electricity Meters Performance

Dear Ambassador Black,

Please find attached an Excel worksheet, *OUR's Request for AMI meters*, with the data requested in your letter of December 3, 2019 in relation to the matter at reference.

Yours sincerely,
JAMAICA PUBLIC SERVICE COMPANY LIMITED

Samuel Davis
Director Government & Regulatory Relations

Attach.

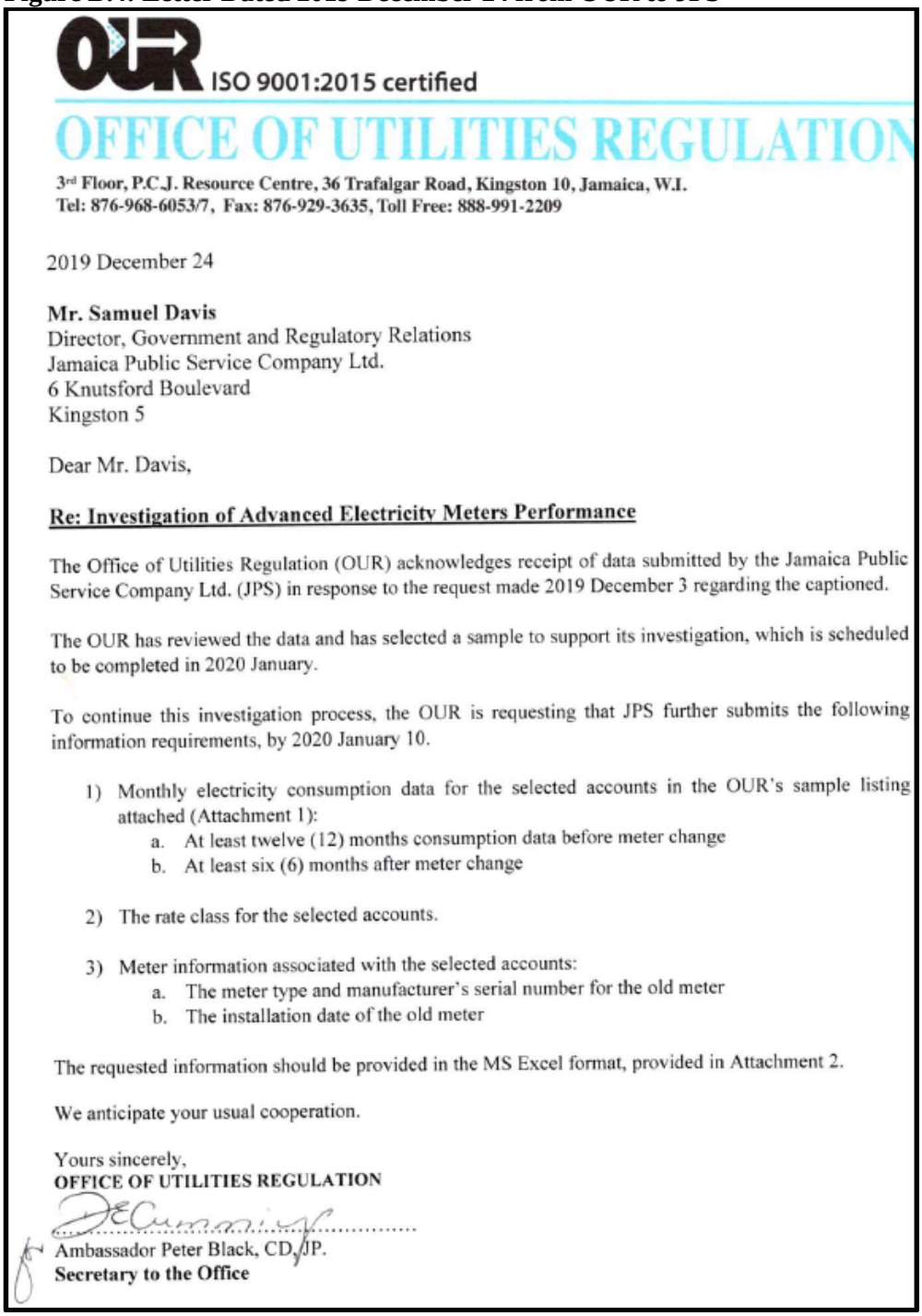
DIRECTORS
SEIJI KAWANURA-CHAIRMAN
SUZETTE BUCHANAN
MASAO IMAZATO
MINNA ISRAEL
CHANG SUP JO
HON. CHARLES JOHNSTON
HA KYOUNG SONG
FITZROY VIDAL
COLIN WILLIAMS

JAMAICA PUBLIC SERVICE COMPANY LIMITED

6 KNUTSFORD BOULEVARD
KINGSTON 5, JAMAICA

Figure B.4 shows correspondence dated 2019 December 24 from OUR to JPS requesting further information on 400 selected accounts.

Figure B.4: Letter Dated 2019 December 24 from OUR to JPS



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OFFICE OF UTILITIES REGULATION

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Tel: 876-968-6053/7, Fax: 876-929-3635, Toll Free: 888-991-2209

2019 December 24

Mr. Samuel Davis
Director, Government and Regulatory Relations
Jamaica Public Service Company Ltd.
6 Knutsford Boulevard
Kingston 5

Dear Mr. Davis,

Re: Investigation of Advanced Electricity Meters Performance

The Office of Utilities Regulation (OUR) acknowledges receipt of data submitted by the Jamaica Public Service Company Ltd. (JPS) in response to the request made 2019 December 3 regarding the captioned.

The OUR has reviewed the data and has selected a sample to support its investigation, which is scheduled to be completed in 2020 January.

To continue this investigation process, the OUR is requesting that JPS further submits the following information requirements, by 2020 January 10.

1) Monthly electricity consumption data for the selected accounts in the OUR's sample listing attached (Attachment 1):
   a. At least twelve (12) months consumption data before meter change
   b. At least six (6) months after meter change

2) The rate class for the selected accounts.

3) Meter information associated with the selected accounts:
   a. The meter type and manufacturer's serial number for the old meter
   b. The installation date of the old meter

The requested information should be provided in the MS Excel format, provided in Attachment 2.

We anticipate your usual cooperation.

Yours sincerely,
OFFICE OF UTILITIES REGULATION

.....
Ambassador Peter Black, CD, JP.
Secretary to the Office

In response to the above correspondence, JPS submitted an MS Excel file on 2020 January 21, as an email attachment, containing the requested information on 400 JPS customer accounts.

ELECTRICITY METERS

ACLARA (GE) I-210+C

OVERVIEW

METER TYPE	DESCRIPTION	APPROVED VARIATIONS/FORMS	
 Aclara (GE) I-210+C	A solid state electricity meter designed to measure energy in residential and commercial applications. This meter type is classified as an Advanced meter and designed to operate as part of an Advanced Metering Infrastructure.	FM1S CL100	• 2-wire • 120V/240V • 100A • 50Hz • 2-way communications capabilities
		FM2S CL200	• 3-wire • 240V • 200A • 50Hz • 2-way communications capabilities
		FM4S CL20	• 3-wire • 240V • 20A • 50Hz • 2-way communications capabilities
		FM12S CL200	• 3-wire • 120V • 200A • 50Hz • 2-way communications capabilities
		FM25S CL200	• 3-wire • 120V/240V • 200A • 50Hz • 2-way communications capabilities

PATTERN APPROVAL DETAILS

PATTERN APPROVAL NUMBER	APPROVAL DATE	EXPIRY DATE	OWNER
TESR21/2016/3026	2016/06/17	N/A	JPS

ACLARA (GE) KV2C

OVERVIEW				
	METER TYPE	**DESCRIPTION**	**APPROVED VARIATIONS/FORMS**	
	Aclara (GE) kV2C	The Aclara kV2C meter family is designed for revenue class metering in commercial and industrial applications. The kV2C offers the required revenue grade metering functionality and advanced power quality monitoring for polyphaser metering. It is intended for use as part of an Advanced Metering Infrastructure.	FM9S CL20	• 4-wire • 120-480V • 50/60Hz • 2-way communications capabilities

PATTERN APPROVAL DETAILS			
PATTERN APPROVAL NUMBER	**APPROVAL DATE**	**EXPIRY DATE**	**OWNER**
OUR-EM/01/2018.02	2018/09/03	2028/09/03	JPS

ACLARA (GE) KV2C+

OVERVIEW				
	METER TYPE	**DESCRIPTION**	**APPROVED VARIATIONS/FORMS**	
	Aclara (GE) kV2C+	The Aclara kV2C meter family is designed for revenue class metering in commercial and industrial applications. The kV2C+ is ideal for harsh environments and comes equipped with a more robust power supply to accommodate the additional power requirements of today's AMI communications.	FM16S CL200	• 4-wire • 120 - 480V • 200A • 50Hz • 2-way communications capabilities

PATTERN APPROVAL DETAILS			
PATTERN APPROVAL NUMBER	**APPROVAL DATE**	**EXPIRY DATE**	**OWNER**
TESR21/2012/1498	2013/10/09	N/A	JPS

APPENDIX D – REFERENCED METER LOT ACCEPTANCE TESTING DETAILS

PROCESSING DETAILS FOR ACCEPTANCE TESTING OF REFERENCED JPS ELECTRICITY METER LOTS

LOTID	APPLICATION DATE	DEVICE TYPE	LOT SIZE	SAMPLE SIZE	OUR DECISION DATE	TOTAL PROCESS DURATION	# OF DEVICE APPROVED
L2	2018/02/18	Aclara I-210+C FM2S	20,160	200	2018/03/28	27	20,159
L3	2018/03/29	Aclara I-210+C FM1S	10,000	125	2018/04/27	19	10,000
L4	2018/04/20	Aclara I-210+C FM2S	9,840	125	2018/05/29	26	9,840
L5	2018/05/17	Aclara kV2c + FM16S	2,400	80	2018/07/09	36	2,400
L8	2018/09/05	Aclara I-210+C FM1S	3,280	125	2018/10/24	34	3,280
L9	2018/09/06	Aclara kV2c FM9S	2,892	80	2018/10/11	25	2,891
L10	2018/09/26	Aclara I-210+C FM2S	2,720	80	2018/10/23	18	2,720
L11	2018/10/19	Aclara I-210+C FM1S	6,720	125	2018/11/05	11	6,720
L13	2018/10/22	Aclara kV2c FM9S	960	50	2019/01/02	49	960
L14	2018/10/22	Aclara kV2c+ FM16S	96	26	2018/12/13	38	96
L15	2018/10/29	Aclara I-210+C FM2S	6,720	125	2018/11/06	6	6,720
L16	2018/11/09	Aclara I-210+C FM2S	5,652	125	2018/11/23	10	5,652
L17	2018/11/14	Aclara I-210+C FM2S	6,720	125	2018/11/23	7	6,720
L18	2018/11/29	Aclara I-210+C FM2S	12,460	200	2018/12/05	4	12,460
L21	2019/02/04	Aclara kV2c+ FM16S	1,096	50	2019/02/26	16	1,096
L22	2019/02/26	Aclara kV2c FM9S	3,360	125	2019/03/20	15	3,360
L23	2019/05/08	Aclara I-210+C FM2S	20,160	200	2019/05/27	12	20,160

DETAILS ON PSEUDO JPS ELECTRICITY METER LOTS

LOTID	DEVICE TYPE	INSTALLATION PERIOD
L9901	Aclara I-210+C FM2S	2017/03/01 – 2017/07/31
L9902	Aclara I-210+C FM1S	2017/08/01 – 2018/07/31
L9903	Aclara I-210+C FM2S	2017/08/01 – 2017/08/31
L9904	Aclara I-210+C FM2S	2017/09/01 – 2017/11/30
L9905	Aclara kV2c+ FM16S	2018/01/01 – 2018/01/31
L9906	Aclara I-210+C FM2S	2018/01/01 – 2018/12/31