Final Report
Forensic Audit of CMP's
Metering and Billing Systems

Presented to:
State of Maine
Public Utilities Commission

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Table of Contents

I. Objectives, Scope, and Major Conclusions

A. Work Scope and Objectives

The Maine Public Utilities Commission (Commission) retained The Liberty Consulting Group (Liberty) to conduct a forensic audit of Central Maine Power Company's (CMP) metering, billing, and related systems. Our work came in the wake of a period of high electricity usage registration and large numbers of customer complaints and inquiries beginning with November 2017. The audit focused primarily on residential customers but also addressed commercial and industrial customers. Our work scope included six major elements. For each of them, we sought to determine the extent to which:

- CMP meters are producing accurate measurements of customer usage, and have done so since November 1, 2017
- Meter-related databases and communications systems are accurately, completely and timely transmitting usage data from meters to meter data management and billing systems, and have done so since November 1, 2017
- Billing systems are producing timely bills that reflect correct customer usage levels and charges, and have done so since November 1, 2017
- Bills accurately convey usage information to customers
- The transition to a new customer information system at the end of October 2017 adequately supported customer service employees responding to customer billing inquiries and high-bill complaints
- Communications with customers have been timely and effective with regard to response times, quality, and responsiveness to high-bill complaints.

B. Background to the Audit

We examined each element of usage and billing accuracy during a time period affected by notable circumstances influencing service usage and continuity, impairing management's ability to respond to customer inquiries and concerns, and creating a climate of public doubt about CMP's ability to provide accurate, timely bills, and effective response to questions about and resolution of problems with billing.

1. The October 29, 2017 Storm

CMP's service territory suffered a rain and high-wind storm that began on the evening of Sunday, October 29. Maximum wind gusts exceeding 70 mph occurred across the coastal region, reaching a maximum of 92 mph at Matinicus Rock. Sustained high winds and gusts across the service territory lasted for about 24 hours. The storm produced unprecedented numbers of customer interruptions. The peak number interrupted reached about 405,000 near noon on Monday October 30. The storm caused outages to a total of nearly three quarters (467,246) of CMP's customers. CMP had restored service to 80 percent of them by November 2 and 97 percent by November 4. It would take 10 days to restore service to the last customer affected.

The AMI network requires power to its components, including meters. An extended outage can affect the numbers of bills required to be estimated and the amount of usage such estimates calculate. High numbers of estimated bills and outage conditions and their aftermath also tend to increase customer inquiries and concerns, making the outage a matter of interest to us as a potential

source of error in measuring usage, as a producer of higher than normal levels of customer contacts, and as a causer of work level increases sufficient enough to degrade the quality of the experience customers have when interacting with the customer service organization.

2. New Customer Information System Installation

CMP implemented an SAP Customer Relationship Management and Billing System ("SmartCare") project to replace its 25-year-old legacy mainframe Customer Service System. CMP transitioned to the new, SmartCare system over the weekend before the major October storm. Systems like SmartCare store customer information, calculate and prepare bills, create estimates for billing customers without available meter registrations of usage, prepare usage and cost information presented on those bills, and provide customer service representatives responding to customer inquiries and concerns with real-time account information.

Developing these systems presents major challenges and change-overs from the system they replace never happen perfectly. Nevertheless, effective management of development and transition minimizes customer-affecting problems in the months following a new system's "go-live" date. Such problems can include large numbers of estimated bills, delayed bills, and billing errors requiring correction. The transition to SmartCare during a period of high customer inquiries and complaints therefore made it appropriate to examine the transition's potential contributions to potential error and customer concern levels.

3. Standard Offer Price Increase

Effective January 1, 2018, the standard-offer supply rate for CMP customers not choosing a competitive supplier rate increased by 18.4 percent, raising those rates from 6.691 to 7.9206 ¢/kWh. This change drove large increases in customer bills, even without a change in usage. Our testing of nearly all bills issued in the November 2017 through April 2018 period showed more than 80 percent of residential customers and more than two-thirds of small commercial customers billed under standard offer prices.

4. Cold Weather

Cold weather has a significant impact on electricity usage. Heating degree days (discussed in Chapter VI: Analysis of Customer Usage) provide an industry standard measure for calculating weather effects on energy usage. By that measure, November 2017 through April 2018 weather proved more severe than that of the prior four years - - even more so when compared with the prior year (by more than 10 percent in some months and 7 percent overall). Customers comparing usage month-over-month from the prior year would thus be comparing bills with substantially different usage levels. Last year's colder winter made weather worth consideration in examining the possible sources of increased usage from November 2017 through April 2018. The large standard-offer supply rate increase magnified the billing-dollar impact of added usage due to cold weather.

Significant penetration of heat pumps employing electricity as a backup source heightens the weather impacts on usage in cold weather. CMP management has cited substantial growth in heat pump use but does not have solid estimates of how many now exist. There is, however, evidence of significant growth. Efficiency Maine's FY2017 Annual Report observed that, "We continued to help Maine lead the nation in adoption of high-efficiency ductless heat pumps, and have now

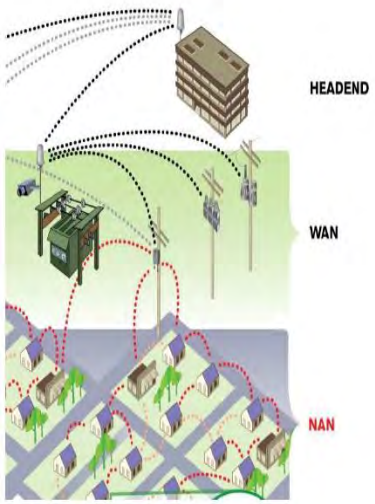
promoted more than 25,700 installations in the past five years." Customers experiencing their first extended period of severe weather after installing a heat pump can find increases in electricity usage surprising, even as they benefit from reduction in the costs of the heating source displaced.

C. CMP's AMI System

From 2010 through 2012, CMP installed an advanced metering infrastructure (AMI) across its service area. About 640,400 of CMP's approximately 647,800 meters operate as part of the AMI system, which provides for registration of electricity usage and its transmission to systems that collect the usage data. GE meters comprise about 364,400 of CMP's AMI meters in service, with model I-210+c comprising almost all (360,000) of them. About 276,000 Landis + Gyr meters make up the remainder of the in-service AMI meter population. AMI meters require the ability to communicate with and regularly transmit the registrations of customer usage through the wireless communications paths and systems comprising CMP's AMI Network.

The chart below shows the main AMI Network components that collect and temporarily store meter information. The communications and data storage systems of the AMI Network must remain up and available at very high rates to transfer successfully usage registrations (readings) from the AMI meters.

AMI Network Meter Data Collection Facilities



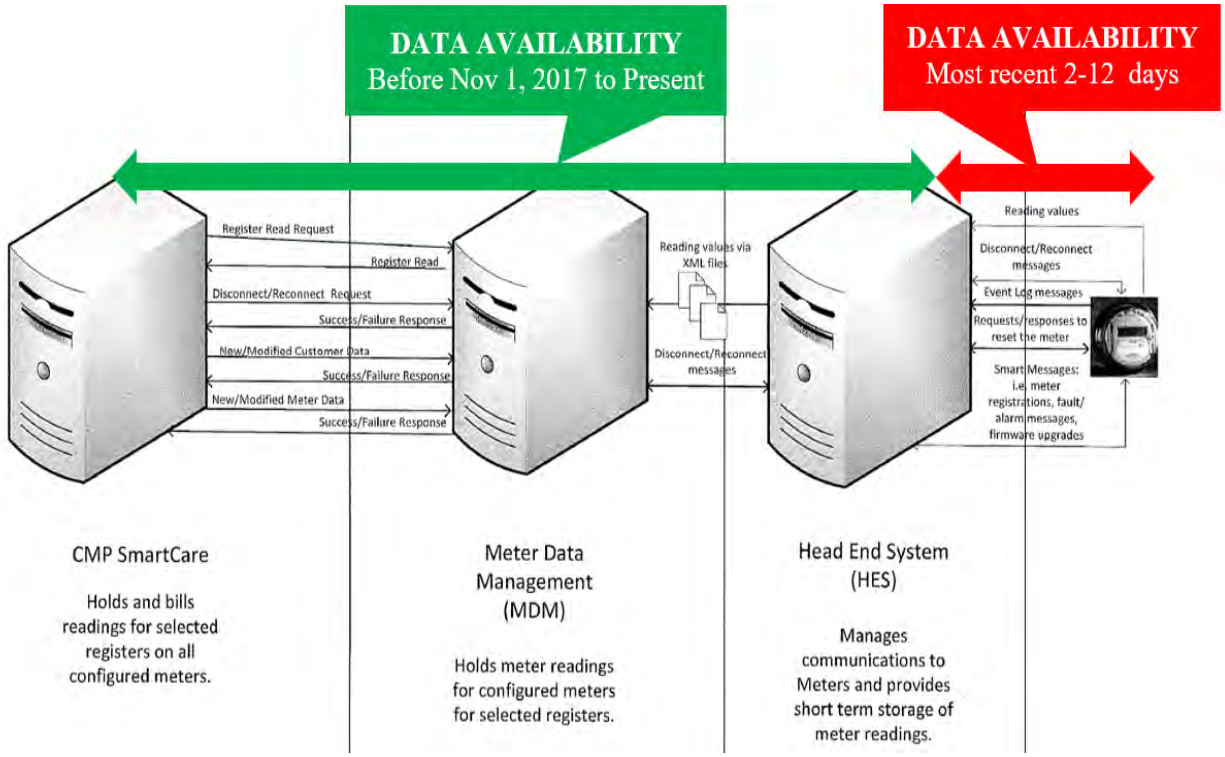
Network Interface Card (*NIC*) - - Connects AMI meters to the network; receives usage registration data for communication through the NAN and WAN
Neighborhood Area Network (*NAN*) - - Collects meter data from localized areas; forwards it to the WAN
Wide Area Network (*WAN*) - - Provides a high-speed path for transmission of meter data to the HES
Head End System (*HES*) - - collects meter data, manages communications to and from meters; monitors AMI Network Health
Repeater: Extends or reinforces NAN communications with the meter.
Extender: WAN communications link; extends network to Extender Bridges and Gateways.
Extender Bridge: WAN communications link on the WAN network.
Collectors: Resident within Extender Bridges, communicate with NICs and repeaters on the NAN; provide a meter-data collection point
Gateway: link between wireless WAN network and a land circuit back to HES

CMP's AMI Network, provided by Trilliant (the Trilliant Communications Platform SecureMesh solution), performs required, two-way communications with CMP's AMI meters. This mesh, wireless system enables communication of registrations of customer usage between AMI meters and a Trilliant Head End System that collects and temporarily stores meter information. Meter data travels next to the Meter Data Management System.

This Itron-provided Meter Data Management System (Itron Enterprise Edition) gathers and stores meter information longer-term. Upon request, the Meter Data Management System uploads meter data to SmartCare (operating on an SAP platform). SmartCare then performs bill-calculation and preparation functions. Management retains PDF images of bills actually sent to customers as part

of its permanent billing records. The next illustration shows the linkages among the systems that move customer usage information, from initial usage registration through billing processes. All major, respected national and international industry suppliers, GE, Landis + Gyr, Trilliant, Itron, and SAP all provided major components of CMP's meter-to-bill process.

CMP Meter-to-Bill Interfaces



The chart illustrates the significant difference in data availability between at the front-end - - AMI meter registration (reading) of usage and its transmission to the temporary storage point, the Head End system. The data-rich environment from the Head End System on allowed us to test nearly all customer accounts for the November 2017 through April 2018 period. The much more limited availability of AMI meter-resident data required recourse to less direct, but still robust indirect means of testing.

A different transmission path supports CMP's remaining (non-AMI) meters. These 7,400 meters serve customers who have opted out of AMI operation. Field personnel manually read them to obtain usage registrations, which they transmit through hand-held devices to the Field Collection System. That system transmits the collected reads to SmartCare.

D. Audit Methods and Work Activities

We undertook a broad and in-depth examination of the organizations, resources, practices, policies, systems, equipment, and results bearing on each of our audit's scope elements. We identified each component of the meter-to-bill process, and conducted tests designed to determine the accuracy and completeness of each. We attempted to produce end-to-end verification that

accurate usage registration led to accurately calculated and submitted bills. These meter-to-bill components consist of:

- Meter registration of usage
- Transmission of usage information from meters to the collection and storage systems
- Collection, receipt, temporary storage, and transmission of AMI meter data by the Head End System
- Collection, receipt, longer-term storage, and transmission of AMI meter data by the Meter Data Management System
- Collection, receipt, temporary storage, and transmission of manually-read meter data by the Field Collection System
- Receipt and use by the SmartCare customer information system of metering data to calculate and prepare customer bills
- Permanently retained PDF images of customer bills actually sent.

Our examination of the interaction with customers and its timeliness included:

- Call center and billing performance
- Recent practices for addressing customer contacts and complaints
- Customer service systems, representatives, and activities
- Call center staffing levels, storm response plan, roles, responsibilities, outcomes, and lessons learned
- Customer and employee communications plans on introducing a new billing system
- Trends in inquiry/complaint resolution timeliness and effectiveness.

This report presents the results of our examination, major work elements of which comprised:

- 52 interviews with management, conducted in successive rounds as we gained knowledge from the other work in progress
- 215 data requests, also conducted in successive rounds as we learned more about the seven major components of the meter-to-bill process
- Random selection of a sample of meters to test in the field for accuracy, based on a statistically-driven approach designed to provide corroboration of the results of management's own meter testing
- Direct in-the-field observation of those tests and recording of their results
- Direct observation of the systems that maintain usage and billing records to understand their operation and to determine how to test their completeness and accuracy
- Securing extracts of more than four million records from those systems to create a master testbed for use in testing their accuracy, completeness, and timely delivery of usage information registered by meters
- Designing and conducting in-person, statistically-driven tests to ensure that the extracted information matched records in the systems from which extracted
- Examining system-in/system-out matches of these millions of meter usage registration data points through all components of the meter-to-bill process
- Independently establishing formulas addressing all billing determinants required to calculate accurately the delivery and supply charges of customer bills

- Examining bills issued to customers between November 2017 and April 2018 for correct and complete bill calculation of supply and delivery charges
- Identifying billing documents-of-record (PDF images of bills sent) and conducting a statistically-driven sampling to ensure a match with our bill calculations and those shown in the system that CMP used to calculate them.

E. Major Conclusions

CMP's meters produce accurate measurements of customer usage. Its meter-related databases and communications systems accurately, completely, and timely collect and store usage, and transmit it accurately, completely, and timely to the billing systems of CMP's customer information system, SmartCare. The meters, systems, and databases have done so since November 1, 2017. The introduction of SmartCare at the end of October 2017 introduced errors and significant delay into the billing process. Billing error rates for delivery and for fairly standard supply arrangements proved minimal in number and in dollar value. We have not been able to match billing calculations for several thousand other supply arrangements, but are confident that the reason for the vast majority of the remaining mismatches is our inability to account fully for the unique billing factors involved. In any event, the total dollar value of these mismatches is also minimal. Management should, however, to rationalize the remaining calculation differences. The overall magnitude of those differences, however, is too small to be considered a contributor to high bills last winter. We also found instances of very uncommon circumstances that cause one of CMP's AMI meter types to register usage inaccurately. Those anomalies may have produced occasions of inaccurate registration numbering in the low thousands since installation of those meters starting in 2010. Not only uncommon, the instances produced error too small to be material overall, but could have had more material consequence for much smaller numbers of customers.

Significant gaps in SmartCare testing and training and in the transition to it produced in its initial phase of operation unnecessarily large numbers of errors requiring lengthy manual correction before bill issuance. A shortage of personnel contributed to the inability to eliminate errors before go-live. Continuing shortages of experienced personnel after go-live unduly delayed fixes to the errors, caused significant customer difficulty in reaching CMP representatives and in getting answers to questions and concerns, and meant overly long delays in resolving billing problems. Customer performance metrics fell below norms and remained so for some time, some of them still today.

The extent and degree of performance degradation contributed strongly to a level of customer frustration, doubt, and skepticism already high due to uncharacteristically large bills last winter. Our analysis showed usage at levels consistent with the expectations that the cold weather of last winter would suggest. Moreover, supplier rates then increased substantially, adding to the effects of higher than typical usage. Weather and rate changes, not meter or AMI system error, caused high usage registration and rates across the system as a whole. Even so, we consider management responsible for generating a high level of customer concern, produced by less than adequate SmartCare development and transition to operations processes and by a continuing shortage of sufficient numbers of customer service personnel after SmartCare go-live.

1. Metering Accuracy

CMP tests some two percent of its meters each year - - averaging 10,000. Meters also undergo manufacturer and receipt testing. Extremely few AMI meters have failed CMP's testing, which sound test-equipment corroboration and test procedures govern. Management's response to the many customer billing inquiries and complaints raised since November 2017 included tests of more than 2,000 meters from customers who reported high-bill concerns. All AMI meters tested well within Maine's accuracy tolerance of +/- two percent, conforming to the results that CMP has obtained from regular testing.

Assuming that CMP employed established procedures and properly calibrated equipment in this regular testing and its post-November testing of meters associated with high-bill concerns, the results demonstrate that meters produce measurements of usage within the established tolerance band, and have done so since November 1, 2017. The organization, staffing, and resources devoted to accurate metering provide confidence in management's efforts in handling and testing meters. However, not having directly witnessed management's testing, we identified a small, randomly-selected, statistically-driven population of meters, whose accuracy testing we directly observed and documented. All 60 of meters tested performed well within the applicable accuracy tolerance. The testing we observed therefore corroborated the results of management's extensive meter testing activities and numbers.

2. GE Metering Anomaly

Almost all of the approximately 360,000 GE model I-210+c meters CMP employs require sustained power to operate effectively. They enter anomalous operation when an uncommon series of events disrupts their restart process, after CMP restores power following outages. Anomalous operation produces two effects:

- Register Anomaly
- Fast-Clock Operation.

a. Register Anomaly

The most significant impact takes the form of registration error ("register anomaly"). Meters record too much or too little registration of usage, depending on which of a customer's two 120-volt phases carries more load from devices energized during anomalous operation.

The infrequency of anomalous operation and the tendency for customer loads to be roughly in balance eliminate this GE metering anomaly as a source of over-registration of use across the CMP system from November 2017 through April 2018 overall. The numbers and consequences of register-anomaly instances taken together were not large enough to have influenced total registered customer usage from November 2017 through April 2018. However, many individual instances have occurred.

We find it highly unlikely that very large numbers of customers experienced large over or under billings. However, management was slow to identify and then to respond to the GE meter register anomaly. Consequently, no reliable means exist to determine numbers of customers affected, or the direction of their anomalous usage registration. Were those customers identified, it would be impracticable to measure the degree of over or under registration, absent means for determining

the meter phases carrying their load (and how much) during anomalous operation. It would be incorrect, however, to conclude that no customers suffered material over-registration or under-registration of usage under the circumstances.

Nevertheless, management should have understood the register anomaly by October 2014 or earlier, were it aware of the GE release notes in 2012. Performing in 2014 the examination that it undertook in 2018 would have disclosed the problem's nature and consequences, upon which, due regard for ensuring billing accuracy would have led to a rigorous temporary solution - - perhaps a permanent one. Management did adopt a more rigorous approach in 2018, and continues today to await the permanent solution it has sought since 2012.

b. Fast-Clock

The second aspect of anomalous GE I-210+c meter operation causes its clocks to register 72 minutes of passage for every 60 actually lapsing. This anomaly can cause readings used for billing to come from actual dates different from those "stamped" for the reading. The bill may thus cover a number of days different from the normal billing month. The number of days included on the bill can appear normal to the customer, which can make the usage identified on the bill seem too high. With a corresponding, large increase in standard-offer supply rates, a bill actually covering perhaps several days more than the bill indicates tends to raise concern about the bill's dollar size.

Unlike register anomaly, however, fast-clock operation does not itself produce register error (but the accompanying register anomaly does). Following proper reset of a GE I-210+c meter, a billing that had been for a "month-plus" bill will be offset by a correspondingly "month-minus" one.

3. Meter-to-SmartCare Usage Data Transmission and Storage

We examined substantial indirect indicators of the performance of the AMI Network in getting meter usage registrations to the Head End System. AMI meters send information multiple times each day through the AMI Network. Historical performance metrics extending across AMI system operation gave no indication of troubling availability declines. Data from the November 2017 through April 2018 period did not raise concern about the availability of the AMI Network to get information to the Head End system.

We had direct indicators of usage information accuracy, completeness and timeliness from the Head End (for AMI meters) to Smart Care. We had the same for 7,400 manually-read meters from the Field Collection System to SmartCare. The systems involved retain information back before November 2017. Verified extracts of CMP system data for about 650,000 meters for each of the six months from November 2017 through April 2018 generated more than four million billing records, which we assembled in a master testbed. That number extended to about 2.3 billion given the systems through which the data passed and the information needed to calculate bills:

- From Head End System to Smart Care for AMI meters
- From Field Collection System to SmartCare for manually-read meters.

We matched values of corresponding meter registrations of use stored in each system: Head End, Field Collection, Meter Data Management and SmartCare. We determined whether the values from whichever of the Head End or Field Collection System first captured usage registrations

remained identical as they passed through all intermediate points and into SmartCare. We match-tested all 12 million or so data points. We found extremely high match rates and no basis for suspecting material levels of corruption, incompleteness, or delay with respect to the usage registration data collecting, storage, or transmission. We concluded that meter-related databases and communications systems are accurately, completely and timely transmitting usage data from meters to meter data management and billing systems, and have done so since November 1, 2017.

4. Billing Accuracy and Timeliness

SmartCare processes perform bill calculation and preparation functions. We sought to verify that billing methods and practices have continued to use the same usage data SmartCare received, that those methods apply the right billing determinants as required by the applicable tariffs, and that the bills issued and received by customers reflect accurate usage and rate calculations. We also examined the extent of billing delays, particularly given the switchover to SmartCare at last October's end.

We found a very high level of correct and full application of billing determinants required by the applicable tariffs to measured usage for residential and small, medium, intermediate, and large commercial customers. Additionally, randomly selected samples of PDF bills actually sent to customers reviewed during our testing showed fully accurate usage and correct rate calculations. We found unexplained variances between our billing calculations and those of CMP, particularly for accounts requiring more complicated calculation (*e.g.*, mid-billing-month changes in supplier rates). There remains a count of 8,300 of our bill calculations that do not match what CMP billed.

Management is already investigating some causes identified, and should continue until it reconciles those still not matched. In any event, the magnitude of unmatched amounts that remain does not call into question the conclusion that billing is on the whole accurate and has been since November 1, 2017. Billing timeliness, as we explain below, has, however, been adversely affected by defects in SmartCare and a shortage of staff to address system problems and manually address individual customer problems.

Most utilities experience some degree of delay following deployment of new customer-information systems. CMP also made changes to its billing cycles, which can also generate long or short bills or billing delays following system cutover. Following the switchover to SmartCare, many customer bill issuance dates fell outside acceptable periods following the gathering of customer usage information to prepare account billing.

5. November 2017 through April 2018 Customer Usage Levels

System-wide, residential and small commercial customer usage from November 2017 through April 2018 was higher than it had been for comparable historical months. We did not find errors in metering, databases, communications systems, or billing systems as material contributors to usage registration during this period. We undertook an examination of weather conditions to determine whether they may have contributed. We found more extreme cold conditions overall, when compared with prior years. We performed several analyses of weather differentials, using usage to degree days - - an accepted means for measuring heating needs.

We calculated usage/degree day ratios for each November through April period for the past five years. We found that the ratios for the current six-month period aligned very closely with matching days from the prior four years. This analysis showed that, after considering degree days, usage during the most recent six month period aligned very closely with historical usage experience.

The large increase in standard-offer supply rates, coming at a time of colder weather, combined to produce large bill increases. That combination understandably increased customer concern about bills. Our analysis found a largely expected level of usage and our testing determined accurate usage registration and billing. Thus, despite understandable customer concern, uncertainty, and even skepticism (given the post-go-live SmartCare circumstances discussed above and below) we attribute high recorded usage and bills this past winter season to cold weather and supply rate increases.

6. SmartCare Implementation

Weaknesses in SmartCare implementation and in the switchover from the system it replaced contributed materially to billing problems and delays, eventually contributing to the customer service organization's inability to sustain effective service. The system has functioned largely as planned. After SmartCare went live, management came to learn of defects in converting data to new formats and in the software that drives billing processes. Extreme numbers of billing exceptions delayed bills, increased customer billing inquiries and complaints, left the customer service organization unprepared to provide meaningful information to inquiring customers, and required large numbers of bill corrections. As many as 10,000 customers a month have been affected by exceptions or delayed billing.

The major weaknesses in SmartCare development and switchover that contributed to customer service and billing problems experienced after the new system went live included:

- Inadequate pre-production testing of the new system
- Inadequate staffing to support project needs
- A focus on project cost and schedule at the cost of attention to quality
- Variable quality of project reporting limiting visibility
- Inadequate project readiness (from premature launch).

7. Customer Complaints and Inquiries

Large numbers of customer complaints about bills followed the introduction of SmartCare at the end of October 2017. Our analysis found substantial billing delays, experienced by thousands of customers in the months following the SmartCare implementation. Billing errors following deployment created incorrect bills and rebills for inordinately large numbers of customers. Since SmartCare deployment, more than 100,000 customer accounts have experienced errors. Additionally, all customer bills during January, February, or March of 2018 contained presentation errors.

CMP management did not communicate effectively with customers affected by billing issues, and was late in notifying Commission staff about customer-affecting billing errors. The lack of transparency exacerbated the situation, creating more distrust, more complaints, and no doubt more customer calls to CMP. Management has also not clearly communicated with the Commission

regarding the number of customers not yet receiving bills or having received significantly delayed bills. Management should delay sending bills known to be incorrect or incomplete, but CMP only began letting customers know that management was addressing their bill issues starting in July 2018 with a call campaign to affected customers. Special considerations regarding payment arrangements and credits for each bill delayed also have been in effect since July 2018.

Customer-service performance metrics remained degraded into 2018, with elevated complaint and inquiry levels. Customers faced limited access to customer service representatives who could discuss issues and concerns during last winter's period of high concern. Many customers found it very difficult to reach the company, experiencing long wait times because call center staffing levels were insufficient to meet the demand. Moreover, many calls were blocked at the phone company switch, due to capacity constraints in CMP's phone system.

We concluded that insufficient staffing, aggravated by unprecedented storm outages and by problems during SmartCare's early operating months, resulted in poor CMP customer experience and a significant increase in customer dissatisfaction and complaints, adding to already high complaint levels driven by other causes.

II. Metering Accuracy

A. Background

We examined the accuracy of meters operating in and outside the CMP AMI system. We examined the organization, staffing, and training of the personnel involved, and their facilities and equipment. We examined how and with what equipment CMP tests meters. We reviewed the results of management's extensive meter testing, both as a matter of course, and in response to high bill inquiries and complaints since last November. We also directly observed meter testing of a sampling of meters we randomly selected.

B. Findings

1. Metering Services Organization, Qualifications, and Training

Effective management of metering requires a sound organization, sufficient staffing, appropriate qualifications, training, and operating procedures. From 2013 through 2016, CMP's Metering Services operated under a Manager, and consisted of two Field Supervisors, the Meter Lab Supervisor, and the AMI group. The AMI group generally included four AMI Meter Systems Administrators, two Meter Engineers, one Meter Technician II, and two Lead Analyst-Project Managers.

The AMI group moved in August of 2017 to an organization headed by the Director of Operations Technology, to whom a Manager of Smart Metering and a Manager of Meter Systems Operations report. By 2017 year-end, the Smart Metering group included 11 incumbents and 1 vacancy. The incumbents included a Smart Metering Manager, a Meter Engineer, a Meter Technician II, and an Associate Analyst, a Meter System Operations Manager, three AMI Meter Systems Administrators, and two Lead Analysis-Project Managers. The Meter Services group (meter and lab technicians) became consolidated with Meter Services in August 2017, under a new manager who operated under the direction of an Electric Operations Director. The group formally moved to Electric Operations in January 2018.

The Field Meter Services group currently consists of the two Supervisors and twelve qualified Meter Technicians (6 Level A and 6 Level B). The Meter Lab group consists of the Supervisor, one Meter Lab Technician and one Meter Lab Tester A. The table below indicates the Meter Services group staffing from 2013 to present.

Meter Services Supervisors and Qualified Technicians

Year	Field			Lab		
	Supervisor	Tech A	Tech B	Supervisor	Technician	Tester A
2013	2	7	2	1	1	1
2014	2	6	5	1	1	1
2015	2	5	6	1	1	1
2016	2	4	7	1	1	1
2017	2	6	4	1	1	1
2018	2	6	6	1	1	1

The two current Field Meter Services Supervisors have 32 to 35 years of meter experience, the six Meter Techs with A classification have 8 to 40 years of meter experience, and the six Meter Techs with B classifications have eight months to five years of experience. Nine of the Meter Techs have associate degrees. Many of the Meter Techs had been electricians and meter readers.

CMP requires its Meter Technician candidates to have a minimum amount of electrical technology education or experience. Candidates to become meter technicians must have a two-year associate's degree in electrical technologies, or, if a current employee, must pass CMP's Electrical Technologies Qualifying exam.

CMP's Corporate Meter Trainer provides classroom and hands-on basic meter training for all self-contained metering, and offers basic National Electrical Code training. Meter Supervisors and experienced peers provide on-the-job training. CMP requires that each Meter Technician demonstrate proficiency to a supervisor, prior to working alone. Supervisors provide classroom training for more complicated transformer-rated meters. Progression to a fully-rated Meter Technician B takes 36 months, with at least a minimum of another 36 months required to become a fully-rated Meter Technician A.

2. CMP's Meter Lab

We examined CMP's Augusta Meter Lab and connected warehouse to verify sound and effective operation. We found it equipped with modern test equipment, evidencing monthly calibration. We found the personnel in the lab sufficiently experienced. The lab was well-lit and very clean. It includes a large warehouse containing a large store of new, repaired, and serviced meters (summarized in the next table). We observed that all meter test results are automatically stored in the Company's ADM system.

CMP Warehouse Meter Stock

Type	Number
Landis + Gyr AXRs	10,481
GE I-210+c	4,099
GE KV2c	1,716
Total AMI Meters	16,296
Non-AMI meters	3,417

Another 3,000 to 4,000 meters (predominantly I-120+c and AXRSD) exist at the different service centers and on trucks. We examined the calibration stickers on the four calibration test sets. All showed calibration within 30 days by a test equipment calibration company against proper standards.

The meter lab has a main calibration test board and three additional sets of calibration equipment. Test board programming permits automatic execution of accuracy measurements at light and heavy load conditions. A Meter Tester sets up each meter and monitors the automatic testing, which takes a few minutes. After verification of each new meter's accuracy through such testing, the tester confirms appropriate meter programming and communication setup. The tester also works with Operations Technology engineers responsible for AMI to test changes to AMI systems, using a special (sandbox) meter board and several signal collectors in the facility.

3. Calibrating Meter Test Equipment

The use of accurate meter test equipment is essential in ensuring that meter-testing produces accurate results. ISO New England Operations Procedure Number 18, Section 9 states that non-induction Watt-hour standards of 0.1 percent or better accuracy traceable to National Institute of Standards and Technology (NIST) shall be certified correct every 12 months. CMP verifies the calibration of its laboratory test equipment every month and its field meter test equipment every 12 months. Its practices meet this standard and conform to good utility practice.

Management employed RFL-brand test boards for laboratory testing between 2010 and late 2017. It calibrated them to +/- 0.05 percent error. Management retired two of its four RFL meter calibration test boards in 2015, and the other two in 2017, because of mechanical and communication software issues. None of these RFL test boards had failed monthly calibration tests since 2010. CMP replaced the retired units with four new WECO meter test boards in September 2017, with upgraded software, and calibration to +/- 0.04 percent error. None has failed calibration tests.

CMP currently employs 69 units for field-testing meters. Management internally performed annual calibration of field testing equipment until February 2, 2018. The error allowed for the field testing equipment was less than +/- 0.025 percent. CMP has, since February 2, 2018, sent field testing equipment to an outside calibration laboratory for calibration verification, using proper calibration standards. CMP now requires that the percent error must be less than +/- 0.020 percent.

Over time, there has been one calibration test failure, upon which management repaired the Probewell device involved, and returned it to service. Calibration has been effective, and has shown minimal risk of producing error. However, management has no procedure for addressing possible accuracy testing error in cases where it finds a device improperly calibrated. For example, identifying meters tested by the device following its last successful calibration date would permit retesting a sample of them to ensure no meters mistakenly tested as compliant are in operation.

3. Pre-Service, Acceptance Testing of Meters

Good practice and public requirements call for a programmatic approach to testing new meters for operability, accuracy, and operation before placing them into service at customer premises. Maine Public Utility Commission Rules and Regulations Chapter 32 requires pre-installation tests of all new meters:

> *All new watt-hour meters and demand meters shall be tested, calibrated and certified as to accuracy by the manufacturer or tested and calibrated by the utility in its own meter laboratory before being installed.*

CMP requires that the manufacturers certify that the accuracy of every meter delivered meets the ANSI C12.20 accuracy class for the meter type. The GE meters must be accurate to +/- 0.5 percent; the Landis + Gyr meters must be accurate to +/- 0.2 percent at both light and heavy loads. The manufacturers provide meter accuracy test result files, which CMP downloads into its ADM meter records keeping system.

CMP also tests samples of new meters in its meter laboratory for quality control. CMP Meter Lab personnel sample 80 meters out of each batch delivered, even for deliveries of a single pallet (80 meters). CMP tests at least ten percent of the meters that come in larger deliveries. CMP does not accept a meter if it fails to meet the same accuracy as certified by the manufacturer. Management recalls no meters ever returned because of failure to meet this acceptance test. However, it has returned meters that had incorrect covers.

CMP also tests two meters from each shipment batch to verify all meter functions. These tests include display capability, voltage reading, meter and NIC firmware, meter tables, communications, disconnect switch operation, as applicable; and kWh per pulse. To ensure that each delivered batch of meters will function when installed, testers use the "Test Environment" of the AMI Network to perform these meter lab tests.

All in-service meters sent to the Meter Lab for repair or otherwise must also pass registry testing to within +/- 0.5 percent accuracy before being returned to service.

4. Accuracy Testing of "Complaint Meters"

As complaints mounted over this past winter season, CMP engaged in testing meters at locations involving customer complaints and inquiries (Complaint Meters). Per the Commission's Chapter 32 Rules, the Company tested 2,290 Complaint Meters, and continues to test meters at customers' request. All meters tested met Commission accuracy limits, save for one non-AMI meter. We did not observe those tests, but management advised that all were carried out in a standard manner, applying the equipment and techniques used to perform tests required to meet Commission requirements. As described above, our review and examination of testing equipment found it appropriate. We cannot validate through direct observation the use of the described equipment and techniques. However, if CMP personnel applied them consistently with our knowledge of its equipment and techniques, then confidence can be placed in their results.

Our experts examined the mathematical significance of the fact that more than 2,000 tests of AMI meters produced no failures to meet the applicable +/- two percent accuracy tolerance. The

numbers of tests and the lack of exceptions, again assuming correct application of equipment and techniques, indicate a low probability of meter error contribution to usage registration between November 2017 and April 2018. Moreover, regular annual testing of two percent of meters by management has produced extremely few failures to meet accuracy tolerance limits. These facts present a backdrop indicating that meter error had an extremely low likelihood of contributing to usage registration from November 2017 through April 2018. We nevertheless sought to perform a statistically-driven sample test of meters for which we could claim direct, eyes-on observation.

5. Our Meter Testing

Working with our statistical experts we sought to identify a number of randomly-selected meters for a test that would produce results having a 95 percent confidence interval, assuming an error rate of two percent. We chose the two percent error rate based on the requirement that 98 percent of meters required to be tested under state standards must exhibit accuracy within the state's +/- two percent accuracy tolerance limit. Considering the numbers and types of meters and their distribution across CMP's service territory, we determined that a population of 60 meters would suffice as a means for providing a useful, statistically-driven means for corroboration testing already performed by CMP. We carried out our tests in the month of September 2018.

The randomly selected meters comprised 60 AMI meters: 24 GE I-210+c meters, 15 GE KV2c meters, and 21 Landis + Gyr AXR-SD meters. These meters included 46 in service at the premises of residential customers and 14 at those of non-residential customers, located in the Portland, Farmington, Brunswick, Rockland, and Belfast areas.

Properly trained CMP personnel conducted the tests during the week of September 24, 2018, with equipment whose recent calibration we had confirmed, under procedures specified in advance and in accord with those we had previously reviewed, and with direct and continual observation by a member of our team. The testing sought to accomplish four things:

- Confirm meter measurement accuracy within the tolerance band of +/- two percent
- Verify that the kWh reading obtained through the test matched the reading contemporaneously communicated to the Head End System
- Verify the accuracy of the meter's reading of date and time
- Download recent-day registration data resident in the meter's memory, for later comparison to data collected through the mesh network that communicates meter registration information to the Head End system.

Prior to the field work, we verified recent, proper calibration of all CMP testing equipment by TMDE Calibration Laboratory. The dispersed nature of CMP's territory required substantial travel time between the meters to be tested. We worked with the CMP personnel ahead of the testing to establish efficient routing.

A member of our team accompanied CMP test personnel in the field and directly observed all testing and information recording activities. During the testing process we photographed each meter face to memorialize meter numbers and kWh readings. We monitored at both ends a call from the field to the central office to secure an on-demand reading that would confirm meter communication with the Head End System and permit observation of the Head End System's receipt of the same reading obtained by the test. We directly observed dates and times as displayed

by the meter. The in-meter register history was downloaded from an optical port on the meter onto a CMP laptop.

The following steps took place at each of the 60 meters:

- CMP technicians removed the meter
- CMP technicians placed the meter test by-pass socket into the meter base and plugged the meter into the test socket
- CMP technicians attached the meter accuracy tester
- CMP technicians recorded light and heavy load accuracies
- CMP technicians removed the test socket and replaced the meter into the meter base
- Our observer photographed accuracy data indicated on a field test device
- CMP recorded kWh reading and light load and heavy load accuracies on a paper form
- CMP downloaded meter register history onto a laptop
- Each evening, CMP copied the Meter Technician's completed paper meter test forms and provided Liberty with paper and electronic copies
- CMP uploaded meter register histories onto Liberty's server for analysis.

All 60 meters tested within the required +/- two percent accuracy tolerance. The largest percent error found was 0.41 percent, with the remaining meters testing at higher accuracy. The clocks of all 60 meters showed values within one minute of real time, save one showing a clock 10 minutes behind. No meter clocks showed future time or indications that they were counting time lapse at too fast a rate.

Some of the GE KV2c transformer-rated meters we tested served commercial or industrial customers for whom demand is recorded. The CMP Meter Technicians conducted a "demand advance for one minute" accuracy test on these meters.

One of the GE I-210+c meters displayed Error code No. 20 - - indicating a hardware issue preventing it from communicating its registration data to the Head End System, but not affecting its accuracy. The field meter tests verified that it registered usage accurately. The CMP meter technician replaced the meter with a new one, returning the removed meter to the meter lab for disposal.

6. Regular In-Service Testing of Meters

Chapter 32 requires that CMP test all self-contained watt-hour and demand meters at least every 10 years, all transformer-rated meters measuring less than 750-volts at least every 24 months, and all transformer-rated meters measuring more than 750-volts at least every 12 months. A February 12, 1962 waiver from the Commission allowed CMP to replace the 10-year requirement for testing in-service self-contained meters with a program of testing at least one percent of its meter population each year. The waiver required that 98 percent of the tested watt-hour meters fall within an accuracy tolerance of +/- two percent, and that at least 50 percent of the meters tested meet or exceed five years of age.

Requirements for accuracy testing samples from a meter population vary from state to state. Some states have implemented sample testing to minimize the burden of testing a large population of meters.

CMP can count in-service meters tested after removal from service for any reason (including customer requests or concerns about high bills) against the required annual numbers tested. These testing sources fill much, if not all, of the required one percent each year. CMP uses a sampling plan to identify any meters it must add to meet the minimum numbers. In 2017, nearly three quarters (73 percent) of the tested meters satisfied the five-year age criterion.

At least 98 percent of the meters tested annually have met the +/- 2 percent accuracy requirement. From 2013 through 2017 CMP has annually tested on average just over two percent of its meter population - - a total of 61,881 meters. That testing produced 63 (0.10 percent) failures of the +/- 2% accuracy tolerance; CMP removed the non-conforming meters from service. These 63 included 16 AMI meters (11 GE I-210+c meters and 5 Landis + Gyr AXR or AXR-SD meters).

We found CMP's practice of periodic accuracy testing, customer request accuracy testing, and statistically selecting and testing in-service meters compliant with Commission requirements. Those requirements match or exceed what we have seen at other U.S. utilities.

7. Customer-Requested Meter Testing

Between October 1, 2017, and June 18, 2018, CMP received a total of 2,367 billing complaints. CMP conducted meter accuracy tests in response to many of them. CMP tested 2,295 AMI meters following such complaints. Every AMI meter (both GE and Landis + Gyr) tested showed accuracy within the +/-2 percent tolerance. One Sangamo electro-mechanical (non-AMI) meter fell outside this range. Two ABB meters fell within it, but did not meet the more stringent 0.5 percent accuracy standard applied by CMP.

We organized customer complaints by meter model in order to identify any correlation that might suggest performance problems with particular models. The next table summarizes the results. It shows an extraordinarily close correlation between the numbers of a particular meter model in service and the numbers of complaints involving that model. This correlation provides one indication that there is not a basis for associating complaints about high bills with a particular AMI meter type. Non-AMI meters have, on the contrary, been involved in a larger than proportional share of the complaints. However, they account for a very low number of the total meter population, making their total contribution to complaints very small.

Billing Complaints by Meter Model

Model Family	Number in Service	Complaints #	Complaints %	Share of Meters	Share of Complaints
GE I-210+c	360,199	1,328	0.37%	55.6%	56.1%
GE KV2c	4,159	15	0.36%	0.6%	0.6%
GE (Unrecorded)	15	0	0.00%	0.0%	0.0%
Landis Gyr AXR	276,049	952	0.34%	42.6%	40.2%
Total AMI Meters	640,422	2,295	0.36%	98.9%	97.0%
Miscellaneous Mech. & Elec.	7,030	72	1.02%	1.1%	3.0%
Miscellaneous	350	0	0.00%	0.1%	0.0%
Total CMP meters	647,802	2,367	0.37%	100%	100%

C. Conclusions

CMP has employed an appropriate organization for managing its acquisition, receipt, warehousing, testing, and replacement of meters. That organization has employed sufficient numbers of adequately trained and experienced personnel. Meter testing procedures have been appropriate and cycles and numbers of meter tests have met or exceeded requirements. Meter testing equipment conforms to industry practice and has been subjected to appropriately cycled and properly performed calibration against applicable standards.

Pre-installation and in-service testing has nearly universally produced results demonstrating AMI meter performance within established accuracy tolerances. Testing of complaint AMI meters by management identified none operating outside those tolerances. Our more limited, statistically-driven testing also showed none operating outside tolerances. We concluded that CMP meters produce accurate measurements of customer usage, and have done so since November 1, 2017.

III. Meter Anomalies

A. Background

We did find one source of error in CMP's measurement of electricity usage. It did not produce material usage recording error overall during the period from November 2017 through April 2018, but has affected some customers. The error occurs when a certain meter model (General Electric I-210+c) resets improperly following a power outage. In the event of a very specific and uncommon sequence of events during post-outage reset as these meters reinitialize, the GE I-210+c meters will operate anomalously in two ways. A meter reset not interrupted by this event sequence will not experience anomalous operation.

These two anomalies are:

- "***Fast Clock***" operation: The meter's clock registers 72 minutes of time passage as each actual 60 minutes elapse, putting it ever further ahead of "real" time as registered by the AMI Network.
- "***Register Anomaly***" operation: The meter registers (records) either too much or too little usage, unless customer load is perfectly balanced among both of the two 120-volt phases serving it from the customer's control panel.

Fast-clock and register-anomaly operation will continue until one of two occurrences:

- "***Special Reset***": not the normal automatic reset after power restoration to the meter, but one requiring intervention by a technician from a central location or at the meter location.
- "***Healing Outage***": reset through the normal, automated process, following a subsequent outage; *i.e.*, a reset not interrupted by the conditions causing anomalous operation in the first place.

B. Findings

1. First Indications of Anomalous GE Meter Operation

GE's Firmware Release Notes dated October 11, 2012 described the Version 2.5.1-7.0.0 firmware upgrade for its I-210+c meters. The notes described several performance enhancements. More importantly, it also described a metering "anomaly" and a fix to correct it. GE classified this anomaly not as a as a "New Feature" or "Enhancement," but as "A change that is correcting a *known problem*."[emphasis added]

The GE firmware release notes contained a section describing how the affected meters could produce erroneous recording of usage (termed "registration"). Specifically, the explanation of the patch for this issue stated that:

> *For the I-210+c FW (firmware) 2.5, the metrology processor status is not always properly monitored by the application processor, which can allow the metrology processor to be reset by* ***an AC voltage sag****, whereas this reset is not properly acted upon by the application processor. This results in the content of a configuration message being erased and set to default, which* ***can cause metering anomalies like significant registration drop or reverse energy****. Patch 7.0 provides proper monitoring which fixes this issue.*[emphasis added]

CMP management agrees that "registration drop" means under-recording of actual usage and that "reverse energy" refers to customers generation of power, meaning that metering is erroneously showing more energy being fed into CMP's system by the customer than the customer is using. This description provides a customer receiving it a substantial enough alert to possible anomalous usage recording to warrant prompt, thorough investigation. However, management stated to us that it has no record or recollection of receiving these release notes until years later. Management observed to us that GE's use of an example addressed under-recording of usage (customer beneficial) - - not a threat of over-recording. That in itself raises a substantial concern; the term "anomalies like" indicates that it may not comprise the only thing that should concern careful management.

It is difficult to imagine an intentional GE decision not to make the notes available generally to purchasers and users of the affected meters. It would appear illogical to document and then fail to communicate a fixable problem, when later discovery of the documentation could aggravate circumstances surrounding liability for customer harm from continuing to operate under conditions known to be defective. Nevertheless, GE may have somehow omitted issuing the notice to CMP. We consider it much more likely, but not necessarily certain, that GE sent the 2012 release notes, but they somehow escaped the attention of responsible CMP personnel until several years later. Firmware upgrades for the I-210+c meters have continued, with successive versions incorporating the Version 2.5.1 - 7.0.0 fix for the metering anomaly issue. The next table shows the number of CMP GE I-210+c meters today operating under release versions predating the one (7.0) available in October 2012.

Upgrade Version	Count
2.5.1-*2.0.1*	357,590
2.5.1-*4.0.1*	360
2.5.1-*6.0.2*	75
Total	358,025

2. The Trilliant AMI Communications System

The October 2012 GE release offered two solutions for installing the firmware patch:

- Field upgrading through the meter's optical port using MeterMate software
- Over-the-air use of the AMI network if supported.

An AMI network with sufficient capability can also allow mass over-the-air programming and firmware updating. Management interprets its agreement with Trilliant as requiring such capability, but Trilliant has to date not provided it, despite attempts to do so over the years. Failing that capability, management has had and still has only the MeterMate option to install the firmware by:

- Field visits to each meter affected
- Beginning with a stock of upgraded meters install them, cycle those removed back to the central office for upgrading to serve as replacement stock for the next cycle, repeating it until all targeted meters have been replaced.

Only a firmware upgrade eliminates exposure to future causes of anomalous meter operation. Management can reset (but not perform the firmware upgrade) on meters from a central location, but meters will remain vulnerable in the future to reset conditions causing such operation.

A review of the October 2012 GE release notes would have made management aware of the potential for GE meter anomalies to mis-record usage. GE's announcement was notably short on detail, but contained sufficient information to warrant further research into issues like:

- Post-outage voltage drop conditions exposing the meters to this issue
- Frequency of occurrence of the resulting meter "anomaly" upon occurrence of the initiating conditions
- Number of meters likely affected
- Extent and magnitude of "registration" errors.

3. Late-2014 Recurrence of GE Meter Issues

We did not find substantial documentation of management's awareness of the GE meter issues or efforts to address them until 2014. A September 14, 2014, CMP email to GE reported the following:

- "A number" of meters each day displaying an incorrect date and time, most of them following a power outage causing them to "lose their clocks"
- Multiple meters with clock times running fast by up to 120 percent
- 10 or more meters experiencing the issue on any given day
- Automatic clock resets through the AMI Network, after which some reset meters continue to show future and clock time, progressing as each day passes
- An August 11, 2014 field investigation of six customer meters with disk emulators moving too rapidly to perform a traditional "stop watch" check.

Management confirmed that the emulator observations of its field personnel indicated possible registration (usage recording) error. A September 2014 email described the clock problems as a daily occurrence, with "…a large number of the GE I-210+c meters with this issue, *sometimes hundreds of them* after a large power event at CMP." [emphasis added]

GE responded in an October 24, 2014, Engineering Analysis Report by recommending the same firmware upgrade (by then incorporated in Version 2.5.1-9.0.3). The GE Report also noted that, pending over-the-air capability to upgrade the firmware, resets over the AMI Network would clear the condition, but without eliminating future vulnerability. We termed these resets "special resets," to distinguish them from other automatic adjustments normally performed over the AMI Network.

4. Management's Late-2014 Strategy for Addressing Anomalous GE Meter Operation

Management decided after review of GE's October 2014 Engineering Analysis Report to await a then-pending Trilliant system enhancement to enable mass firmware upgrade over-the-air. Management cited to us a number of reasons for this approach:

- Lack of belief that registration errors were at issue (noting the failure of the 2014 GE Analysis Report to discuss them)
- The belief that that anomalous GE meter operation was not widespread

- The belief that the AMI Network enhancement was imminent
- The ability in the interim to address individual cases through special resets, as management discovered them.

We describe below a 2018 management investigation of the issue. It also provided definitive evidence of the impact of register-anomaly operation of these meters. Had management secured it in 2014, what it learned in 2018 it would have known in September 2014.

5. Management's 2018 Investigation of Meter Anomalies

CMP's responses to the large number of customer high-bill complaints in early 2018 included a March 2018 examination of anomalous GE meter operation. Management reviewed 2014 information about questionable meter operation instances and pressed Aclara (the successor to GE's meter business) to analyze outage events causing anomalous operation, the consequences for meter registers, and actions required to prevent those conditions.

Aclara responded to CMP in a June 15, 2018 report. This 2018 report provided the first clear explanation of the causes of the phenomenon and of how specifically it caused over- and under-registration. GE I-210+c meters have to re-initialize after an outage that interrupts power to them. After re-energization begins, the AMI Network normally performs resets automatically. However, if a material voltage sag occurs during a small time window during reset, the meter reverts to an anomalous configuration.

Aclara's report explained the sequence of events that must occur in order and in an extraordinarily tight time window to produce these anomalies:

- Following an outage, a meter begins to initialize (reset) when power is restored
- At about 3.36 seconds after restoration of power to the meter and while initialization is underway, voltage at the meter must sag to less than 90-volts on Phase A (one of the two 120-volt phases at the meter)
- This voltage sag must occur for at least 100 milliseconds and the sag must be maintained throughout a 66 millisecond window of vulnerability during which the metering processor resets, but the other, control processor has not reset.

Following these uncommon conditions, the affected meters produce error in the two ways described in the next subsections.

a. <u>How Register Anomaly Occurs</u>

After power is restored, the meter reverts to a 120-volt meter configuration (only Phase A), rather than the required, 240-volt configuration (involving both phases, A and C) - - producing register anomaly:

- Usage at customer premises carried by 120-volt Phase A registers at twice actual amount used
- No usage registers for load on the second of the two phases (Phase C)
- 240-volt usage registers accurately.

The anomalous 120-volt configuration has the following impacts on the meter's registration of customer usage:

- *240-Volt Circuits*: Load operating at 240-volts (major load sources at the customer's premises, such as water heaters) is always balanced between the two 120-volt phases (A and C), producing accurate registration for that portion of the load. For example, therefore, if during the fast clock configuration, all customer load is at 240 volts, no error occurs in registering usage for that portion of the load.
- *Balanced 120-Volt Loads*: If customer load on the two 120-volt phases (A and C) is equal, the balance in load will also produce no error.
- *Higher Phase C Load*: If there is more load on Phase C than on phase A, under-registration will occur because the meter registers none of the usage occurring on Phase C.
- *Higher Phase A Load*: If there is more load on phase A than on phase C, over-registration will occur, because the meter registers twice the actual usage occurring on Phase A.

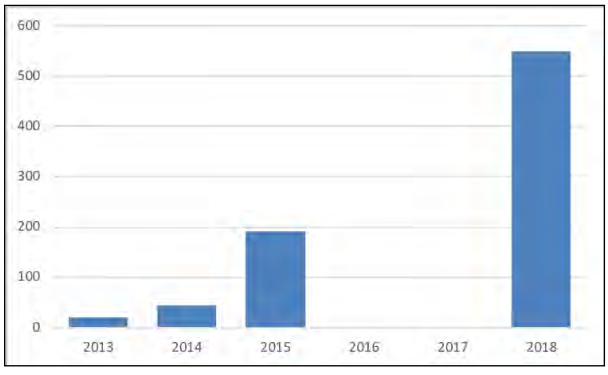
b. How the Fast-Clock Anomaly Occurs

The meter resets at 50 Hz, not the required 60 Hz. This anomaly produces the fast-clock phenomenon - - the meter's clock registers time passage at 120 percent of actual. Depending upon when the meter enters fast clock mode, a customer bill based on the meter's clock could use an opening reading for the period actually made earlier than the bill implies. If the meter has been reset before the reading for the closing day of the billing period, its clock will record the closing date accurately. If the meter had been in fast-clock operation for multiple days during the billing period, the usage could appear to the customer high because the readings actually span a larger number of days. After the meter is reset, the following's monthly bill will appear to the customer low for the indicated number of days because the readings actually span a smaller number of days.

6. Extent of Anomalous Meter Operation

The circumstances required to produce anomalous GE meter operation are uncommon. The next table shows the number of meters management tracked as affected by this issue. The gap in 2016 and 2017 shows inconstant application of measures to identify and correct GE meter anomalies using the special-reset process.

Anomalous Operation Instances Tracked

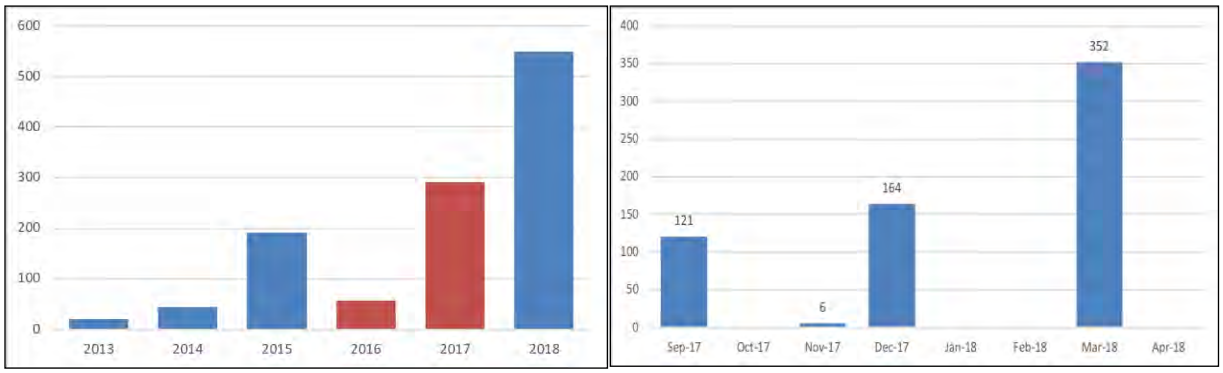


We observed to management that these numbers appeared too low. Management has since undertaken a review that has identified some 2016 and 2017 instances not included in its tracking.

The left side of the next chart shows 2016 and 2017 conditions lately identified by management as possible instances. The right side details counts associated with specific outage events:

- September 2017 - - meters that the data indicates likely appear to have remained in register-anomaly operation from September 1st through October 30th when restoration of power after a healing outage allowed the usual meter reset process.
- December 2017 - - a group of meters possibly in register-anomaly operation for an extended period (December 24th through January 4th).

Anomalous Operations Instances Added Recently by Management



7. Management's Efforts to Address Registration Error

While awaiting any permanent solution, management faced the need to adopt appropriate interim measures. Management instituted in early 2018 more rigorous efforts to identify anomalous GE meter operation. Each day at about 11 p.m., it runs a routine that identifies GE and Landis & Gyr meters whose clocks do not match Network time. Personnel reset the clocks of these meters remotely the next morning. The following day, management uses the same report to identify meters with clocks still recording times significantly into the future, even after the previous day's reset; *i.e.,* "suspects". These suspects, those whose clock time has advanced significantly (4+ hours, recognizing the 12 minute-per-hour gain in fast-clock operation) are sent to meter engineering personnel. Personnel there then perform from a central location the special resets needed to eliminate anomalous operation.

Meter engineering personnel in 2014 did perform some special resets before 2018, but on a basis that appears very irregular in identifying instances. The personnel involved in efforts to identify and correct instances in this period cited substantial competing responsibilities (*e.g.*, SAP SmartCare system implementation), making resource adequacy, rather than lack of anomalous operating instances, the likely cause of low manual reset numbers. Even now, the time to make corrections can reach multiple days, as the next chart summarizes.

Days to Reset "Fast Clock" Meters

2018 Month	Days to Reset
March	12.02
June	0.44
July	6.80
September	2.46

The method for counting and clearing instances of anomalous GE meter operation advanced considerably by March 2018. However, gaps remain. First, the previous data show longer than two-day correction periods. Second, the two-day process can miss some instances. For example, a "suspect" meter identified on the first day may disappear the next day due to a subsequent self-healing outage that resets it, despite having measured customer usage erroneously.

With Phase A and Phase C loads generally balanced at customer premises, register-anomaly mode makes only a small degree of error likely. It will, however, almost always be present in some degree during anomalous GE meter operation. For a small number of individual customers, the impacts (in either direction) could be substantial. For example, a customer away from the premises during a cold snap might shut down most sources of load, but mistakenly forget to turn off an inefficient space heater. If that heater is on Phase A when anomaly mode occurs, the customer may see a properly alarming level of usage when the bill arrives. Alternatively, that same customer may see a bill with very low usage if that heater was on Phase C for the same period.

The number of occasions of register-anomaly operation are also small, when measured against the approximately 360,000 susceptible meters. The required time window and the amount and duration of voltage sag must coincide during initialization following an outage for these registration anomalies to occur. The time windows for the required chain events to induce anomalous operation are extraordinarily small.

Operating 360,000 meters for 365 days produces more than 13 million "meter-days" of operation each year. However, while small as a percentage of total meter-days of operation, management has observed that hundreds may occur after major weather events, and some may happen most days. The October 2017 storm produced prolonged outages. It took four days to get 80 percent of the 467,246 affected customers restored and 10 days to reconnect the last. Management's failure to track events rigorously before 2018 means that it has no substantiated estimate of the number of anomalous operating instances that have been occurring since 2010. Even management's procedures now require a meter to show an accelerating clock on a monitoring list for two consecutive days before listing it for special reset to correct register anomaly.

The two-day requirement limits but does not eliminate a gap in reporting of anomalous operation that has always existed. A subsequent outage (unless it also suffers the uncommon conditions producing anomalous operation) will correct fast-clock and register-anomaly operation. Self-healing outages may render it impossible to identify that anomalous operation has occurred. Self-healed instances never got recorded, and still will not, if they occur between day one and day two of management's current identification and temporary correction procedure.

We are confident in concluding that the numbers of instances of register-anomaly operation by the GE meters are not large enough to have contributed to over-registered usage from November 2017 through April 2018. However, we conclude with equal confidence that many instances have occurred, remain unknown, would be extraordinarily difficult to identify individually, produced small error in most cases, but, logically, are likely to have caused significant over- and under-billings for a very small number of customers.

8. Read Date Anomalies Resulting from 50Hz Meter Operation

Left uncorrected, the 50 Hz anomalous configuration's 12-minute hourly clock gain can lead to misleading billing period measurement. Management performs little validation of the data transferred from the meter through the Head-End System to the Meter Data Management system. The latter system ensures collection of data, but does not validate the associated date or time of the meter reading, rather the Meter Data Management System stores gathered readings by date and time presented by the meter. A weekly job run every Sunday purges future dated reads from the Head-End database. In addition, reads only forward to the MDM for use as a valid read after the reading date becomes current.

The system stores meter usage data collected for any given day at midnight. Normal and relatively common meter clock drifts ahead or behind AMI Network time cause an automated network resync of the clock. However, clocks more than 15 minutes off actual time cannot be reset automatically by the network. They require manual initiation of a clock resynchronization procedure from the Head End System.

CMP's daily reports identify meters that require manual clock resetting and management has a process in place to work these error reports on a daily basis. However, prior to 2018 CMP did not rigorously identify or correct meters in fast-clock anomalous operation. Absent special reset, the fast-clock aspect of anomalously operating GE meters causes them to record midnight (actual time) readings as happening the next day. Gaining four hours every day until special reset, readings can get two or more days ahead, absent a rigorously applied process for identifying and specially resetting them. The purge process and that fact that future reads are not sent from the HES to MDM until the reading date is the current date limits to seven the number of days ahead for read dates used for billing.

Depending upon when the meter enters fast-clock mode, a customer bill clock could use an opening reading for the period actually made earlier than the bill implies. If the meter has been reset before the reading for the closing day of the billing period, its clock will record the closing date accurately. If the meter had been in anomalous operation for multiple days during the billing period, the usage could appear to the customer high, because the readings actually span a larger number of days. Additionally, following special reset, the next monthly bill will appear to the customer low for the indicated number of days because the readings actually span a smaller number of days.

A meter reset that corrects fast-clock operation will cause advance readings to be overwritten if not already erased by the Meter Data Management System's weekly house-keeping procedures.

9. AMI Network Capability Enhancement Efforts

CMP has continued to work with Trilliant to seek enhancements that would permit over-the-air firmware upgrading. This work has focused on expanding the capacity of a communications card on the meter, the network interface controller, to support the data exchange required. Tests performed in 2015 on a potential solution offered by Trilliant failed. The next table summarizes the current schedule for upgrading the AMI Head End System hardware and software, firmware upgrades for its network interface controllers (NICs in the meters), collectors, and radios to provide capacity for upgrading the meter firmware over-the-air through the AMI Network.

Trilliant Upgrade Schedule Milestones

Activity	Date
Deploy Extender Bridge & Collector Firmware	3rd Quarter 2018
Proof of Concept SBX Environment Built	3rd Quarter 2018
Deploy Repeater and GE Meter NIC Firmware	4th Quarter 2018
Infrastructure Delivered and Installed	4th Quarter 2018
Head End System Testing and Go-Live	1st Quarter 2019
Deploy GE Meter Firmware Upgrade	October 2019

It is difficult to place confidence in the schedule that exists now. Furthermore, the lack of substantial correspondence across the years with Trilliant does not give confidence that deciding on an "over-the-air" solution was based on reasonable expectations of timely success. More likely it reflects a management view at the time that the solution could be placed on an essentially indefinite timeline.

Significantly, the correspondence (or its lack, more precisely) and record keeping also do not show concentrated efforts over prior years to identify the frequency and extent of anomalous GE meter operation or to probe more carefully prior to 2018 the under-registration accuracy risk. Therefore, we do not consider the decision to place the permanent solution on an uncertain Trilliant path sound.

10. An Option Not Explored by Management

The 2018 efforts to explore the GE meter anomaly problem used technology available and relied on knowledge gainable through reasonable 2014 investigation. However, the only option apparently considered substantially was to await an over-the-air, AMI Network-delivered solution. Management could have considered a program of cycling a set of meters out of the field to the shop for upgrading and then back to the field to replace others, which would then seed the next cycle. This approach could take advantage of the existing store of meters (requiring one initial set for use in the first replacements).

The current meter stock could have "seeded" a number of unaffected or upgraded meters sufficient to conduct an initial cycle of changeouts in the field. The meters removed could then be upgraded in the shop, supporting a continuing series of cycles until completion of a program of upgrading a targeted population of the meters requiring upgrade. We found no documentation of the likely requirements and costs produced by such an approach.

Such an approach, carried out over a multi-year cycle, might have produced reasonable costs and it could have been completed by now. At the least, we believe that investigation and planning in 2014 should have led management to disclose the problem, its uncertainties, and possible alternative solutions to stakeholders at that time.

11. The Landis + Gyr Whiskers Issue

Management learned of another utility's experience with a "metal whisker" issue involving the operation of the same type of Landis + Gyr AXR meters as used on CMP's system. Its investigation of the issue determined that it could not affect CMP's AXR meters.

A crystalline metallurgical phenomenon can spontaneously produce a tiny, almost invisible, hair-like growth from a metallic surface. This fragile metal whisker can cause a short circuit when it occurs between electrical connectors or soldier joints on a circuit board. CMP learned of a sister utility's experience with the phenomenon in July of 2017. A metal whisker occurring at a spade connector on the mother board in some of that utility's AXR meters was causing a short circuit that resulted in voltage metering issues. The higher voltage produced by this phenomenon in the meters produced high usage registration. The other utility identified the affected meters through their higher than normal voltage registrations, correcting the issue by realigning the spade connector in the affected meters.

CMP had not observed any cases of higher than normal voltages in its AXR meters. Management undertook an investigation to determine whether, despite the lack of adverse experience, its meters could be vulnerable to metal whiskers.

The investigation, supported by Landis + Gyr, identified substantial motherboard differences between the CMP meters and those of the other company. Those other meters employ an integrated AMI board, the CMP counterparts use a separate, non-integrated, AMI board. The difference meant that whisker-forming conditions did not exist in the CMP meters.

C. Conclusions

1. Recognition and Investigation of the Anomalous GE Meter Operation

CMP has, since 2010 been experiencing conditions that expose all but about 6,000 of its 360,000 GE I-210+c meters to erroneous registration of customer usage in an uncommon set of circumstances. Management received definitive evidence of the potential for such erroneous registration in June 2018. That knowledge and actions taken in light of it should have come as early as 2012 and certainly by 2014.

2. Reliance on Trilliant System Enhancement to Address the Issue

Management decided in 2014 that it had no reason for suspecting such error: (a) despite its documented acknowledgement of the potential for registration error, and (b) without requiring investigation of the type that in 2018 confirmed such error. Management reportedly expected in 2014 a soon-to-come AMI Network enhancement that would permit mass, over-the-air elimination of the source of registration error at all the affected GE meters. Reliance on an over-the-air solution

led it to decide in 2014 on a course of awaiting this enhancement, given that there was no indication that affected meters could over-register, and that the impact was confined to clock issues only.

The documentation retained by management does not evidence persistent or concerted efforts in or before 2014 and in the years immediately following to require meaningful, detailed plans and schedules from Trilliant, or pressure to accelerate work to provide the capability. The current schedule calls for 2019 availability, but substantial work remains.

Management's continued reliance on a Trilliant over-the-air solution remains a matter of significant concern. The failure to find a solution since 2010, the lack of a proven concept for solving the problem even today, and management concern about meeting current schedule make it wise, as it has been since 2014, to consider other options for providing a current solution.

3. A Missed 2014 Opportunity

The 2018 efforts did identify clearly the registration error risks; performing them in 2014 would have done so as well. Enough information existed in 2014 to pursue efforts like those undertaken in 2018. Management should have examined by 2014 at the latest, but it did not, other options, including cyclical removal/replacement of meters at risk through a multi-year staged program. Had it undertaken such work, it would have provided a sound estimate of costs and exposure reduction to share with the Commission and stakeholders in an effort to permit a prompt decision on remediation efforts, considering well-founded, carefully analyzed costs and benefits of remediation alternatives.

4. Customer Consequences from Metering Anomaly

The circumstances causing anomalous operation of GE meters and the generally self-moderating nature of their registration error make clear that the issue did not contribute materially to the total customer usage recorded during the period beginning in November 2017. The numbers of meters that experienced erroneous registration are proportionately very small, but over the years likely fall at least in the few thousands.

We do not consider it at all likely that a large number of those who did experience instances of anomalous GE meter operation either substantially benefitted or were harmed as a result of incorrect usage registration. Nevertheless, clearly some customers have overpaid and some underpaid for service due to anomalous operation of GE meters since 2010. There is no feasible means, other than customer-by-customer analysis to even begin to identify each. Even upon such identification, variability in customer usage would make measuring the over or under charging very uncertain and problematic.

The data that management has collected over the years permits no definitive answer, but the numbers of instances of anomalous GE meter operation due to interrupted resets certainly substantially exceeds what management has tracked.

5. Soft Resets as an Interim Measure

Management failed to rigorously apply GE's recommendation to apply the special-resets necessary to take affected meters out of anomalous operation until early 2018. Taking those actions earlier

would have eliminated instances where anomalous operation was permitted to extend for multi-day periods. Management has no supportable estimate of the number of fast-clock and register-anomaly meter instances that occurred before early 2018, but would have, had it earlier executed a rigorous identification and temporary correction processes.

The methods implemented in early 2018 provide major improvement in that identification, but fail to have the capability to identify short-duration situations (those corrected by self-healing outages occurring before its early morning clock checks on meters suspected of fast clock operation on reports from 11 p.m. the preceding day). The need for a meter to appear on two consecutive lists before being treated as requiring soft reset should be reduced to one, by performing special resets on each meter making the suspect list on day one.

IV. Data Collection, Storage, and Transmission

A. Background

We examined systems used for communicating usage data from meters to meter databases and from them to the customer information systems to determine whether they transmit data without error or omission and on a timely and secure basis. We tested the accuracy, completeness, and timeliness of information sent from the meter for eventual use by the SmartCare customer information system for billing.

CMP's meters accumulate massive amounts of usage data across a broad population of customers. AMI systems and processes transmit that data to locations for categorization and maintenance pending eventual use in customer billing. Meter information receipt and housing require careful design, sophisticated systems, regular testing, and a high level of availability. Equally essential and sophisticated means for communicating data between those systems the ones supporting billing must also exist.

AMI networks, like other systems that rely on communication and control, depend upon on clear and error free data sent to and received by the various devices involved in getting data from meters to the billing system. These systems used must possess an appropriate amount of bandwidth and speed to accommodate the data transmitted, received, and managed. Sufficient redundancy in the communications paths must also exist, to prevent loss of one device from jeopardizing the availability and effectiveness of the system. For example, loss of a collection node should not prevent the AMI system from gathering data from meters normally covered by the lost node, nor should it prevent operation of automated distribution equipment controlled through that node.

We designed and executed a test process seeking to validate that, from initial registration (usage recording by the meter) through printing of the bill actually sent:

- An accurate registration of usage at the beginning of the billing period occurred (*addressed in the preceding chapter*)
- An accurate registration of usage at the end of the billing period occurred (*addressed in the preceding chapter*)
- Those readings were accurately, completely, and timely communicated to, stored in, and subsequently communicated by each system along the way from meter registration to the system that calculated bills
- Billing systems and processes used readings matching those that began with meter registration, unless adjusted for valid reasons
- Billing calculations included and accurately accounted for all determinants (addressed in the next chapter)
- Bills maintained in the company's system of record reflect accurate and complete calculations (addressed in the next chapter).

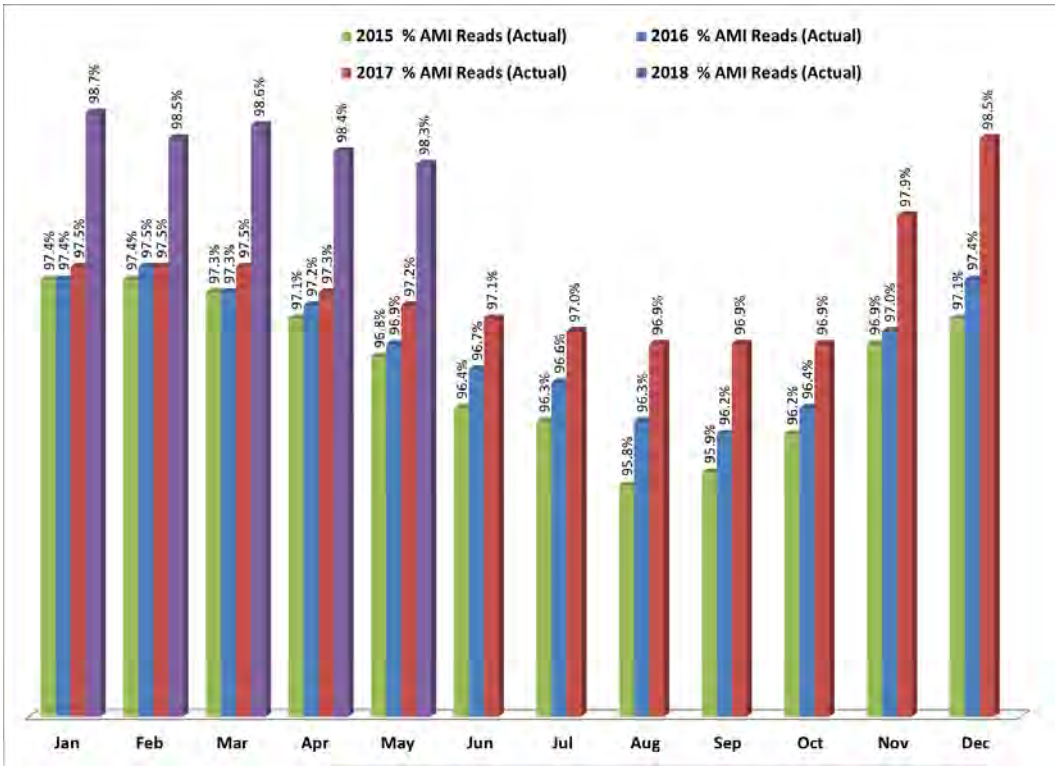
B. Findings

1. *Testing Meter Registration to Head End Performance*

a. AMI Meter Reading Performance

The percent of bills calculated with actual meter readings (not estimated) offers an overall, albeit indirect measure of AMI network performance. An AMI network depends on how well it collects meter readings in support of monthly billings. CMP has experienced a high AMI read rate, which has improved yearly. CMP's read rate performance has typically improved during late fall and winter after leaf fall provides better reception on the network.

Percent of Bills Based on Actual AMI Reads



Performance from November 2017 through April 2018 fell within a narrow range, 97.9 to 98.7 percent. The rate of bills using actual AMI readings reached the highest levels attained since 2015.

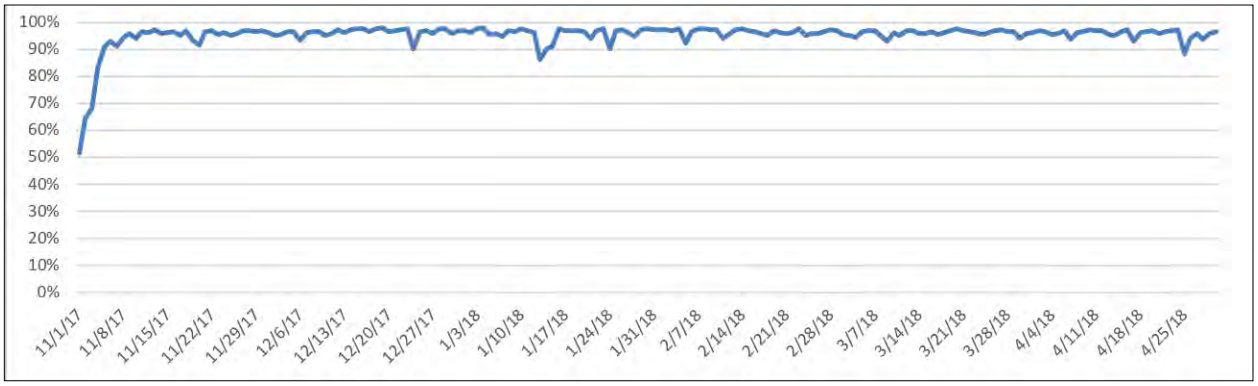
CMP generally needs only one reading per month per meter for billing. The AMI network collects meter data nightly from all connected meters, however. We examined daily continuity of transmitted reads to provide another means for examining the operation of the network, given that it gives a more granular view of the ability of the network to communicate with AMI meters. Overall, daily read rate performance averaged from 94.3 to 94.7 percent from 2016 to 2018, meaning that over 94 percent of AMI readings were collected on the scheduled read date. The following table presents the yearly average of daily read rate performance across all meters and the three subsets identified above. Read rates for these groups of customers have run at a level that does not suggest communication failures to the head end as a cause of incorrect bills.

Meter Read Rates

Meter Type	2016	2017	2018
All AMI Meters	94.6%	94.3%	94.7%
Complaint Meters	93.8%	93.8%	94.2%
High-Use Meters	95.1%	95.2%	95.3%
High-Dollar Meters	93.9%	94.1%	94.4%

The following charts depict daily read rate performance from November 1, 2017 through April 30, 2018. Performance ranged from a low of 51.8 percent on November 1st to a high of 98.1 percent. The low on November 1, 2017 reflects loss of power to the AMI Network and other consequences following the October 30th storm. It took four days to get 80 percent of the 467,246 affected customers restored and 10 days to reconnect the last.

Daily AMI Meter Read Rates



In addition to overall performance, we examined data for three additional subsets of customers:

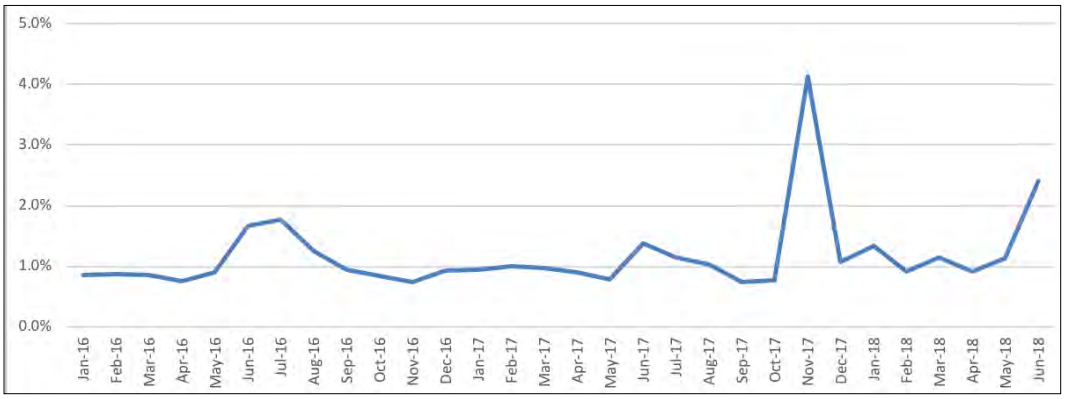
- Customers registering billing complaints between November 1, 2017 and May 31, 2018
- Customers whose usage during December 2017, January 2018, and February 2018 was at least 50 percent higher than that of the prior winter
- Customers whose total charges during December 2017, January 2018, and February 2018 were at least 50 percent higher than those of the prior winter.

Comparing their daily read rates with those of customers overall disclosed no material gap. The high daily read rates for customers overall and for these sub-groups show no indication of communication failures to the Head End System as a cause of erroneous billings.

Year	Bills	
	Issued	Estimated
2016	99.0%	1.0%
2017	98.8%	1.2%
2018 June	98.7%	1.3%

Inability to secure data from meters through the AMI network generally results in usage estimation by SmartCare. The Commission uses six percent as one basis for measuring excessive numbers of estimated bills. CMP's annual estimation rate has averaged 1.0 - 1.3 percent since 2016. CMP typically experiences increased estimated bills during the summer because more leaves on the trees cause the AMI network more difficulty getting readings, as the next graph shows.

Percent of Bills Estimated



The October 30, 2017 storm led to higher than usual numbers of November estimated bills (about 24,000, or 4.1 percent). Storm damages and the need to use resources for restoration before obtaining actual readings drove the increase.

We also reviewed the level of estimated bills within our testbed for all customers and for the same three subsets of customers: Complaint meters, High-Use meters, and High-Dollar meters. Overall, testbed data shows 65,000 estimated bills (two percent), summarized in the following table. Overlap exists among them; *e.g.*, a Complaint meter may also be a High-Use or High Dollar one.

Estimated Bills by Category

Category	Bills	#Estimates	
		Number	Percent
High Use	144,483	7,831	5%
High Dollar	152,852	13,467	9%
Complaints	16,476	596	4%
All	4,318,164	65,422	2%

The highest numbers of estimated bills for Complaint Meters occurred in November, December, and January. The other categories experienced their highest numbers in October, November, and January. All three subsets received more estimated bills than customers as a whole, with High Dollar accounts receiving the largest proportion. The majority of estimated bills issued during our review period came in November, following the October 30th storm damage and power loss. For more than 20,000 customers, the first bill received under the new SmartCare system used estimates.

Estimated bills can trigger customer inquiries and complaints. SmartCare bill estimation does not take into account degree-day (temperature) impact; CMP's legacy system used a usage trend factor (UTF) for seasonal estimation based on past 60-day period. A sampling of actual readings taken during the prior week determined the percentage of change. UTF updates occurred weekly. Also, "from-to" codes for seasonal customers indicated occupied season and estimated zero use during unoccupied seasons. Estimating based on historical usage (same month, prior year) generally works best during normal weather. However, degree-day-based estimates better address unusually cold or hot periods, because the estimating formula incorporates temperature variations. Without

degree-day consideration, usage can be under-estimated during extreme cold spells, making the following month's bill look higher than normal because its reliance on an actual reading "corrects" for the prior under-estimate by adding the prior month's amount of actual usage not captured by its bill.

b. Packet Data Loss Rate

We have data about the rate at which the AMI Network "lost" data transmitted from November 2017 through April 2018. This data offers another way to examine performance in meter-to-Head End communications. CMP monitors and measures AMI Network operation daily, producing extensive data, which we examined. Management has strengthened coverage and continuity of its availability since installation (customary for utility installers of similar networks). Monitoring system performance permits identification of gaps, weak spots, meters regularly out of over-the-air contact, and seasonality variabilities. Identifying them discloses network strengthening and enhancement measures that drive rates of successful data receipt ever closer to 100 percent.

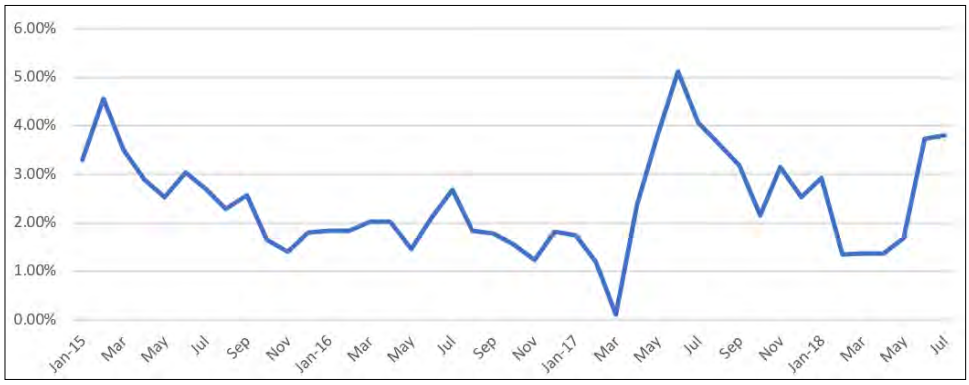
The AMI network transmits meter data in "packets." These packets can become lost when they do not reach their intended destination across the network. Automated senders and receivers seek to confirm successful transmission, and automatically request resends. Packets sometimes get "lost" (*i.e.*, receipt is not confirmable). Packet loss results after multiple transmission attempts, from errors in transmission (typically over wireless networks) or network congestion.

Persistence of the inability to transmit actual meter usage registrations leads to estimated billings. Such bills do not, per se, constitute "errors," but do not always conform to actual usage for the period involved. Thus, estimated bills can produce customer concern, particularly in extreme weather and when customers have other reasons to question the "quality" of bills they receive.

We have no reason to believe, however, that disruptions to the mesh network can cause inaccurate usage registration data to be registered by the meter or transmitted. Even were that outcome possible, the error would have to somehow persist over time. Otherwise, later transmission of a correct reading would adjust future bills to eliminate error temporarily induced earlier.

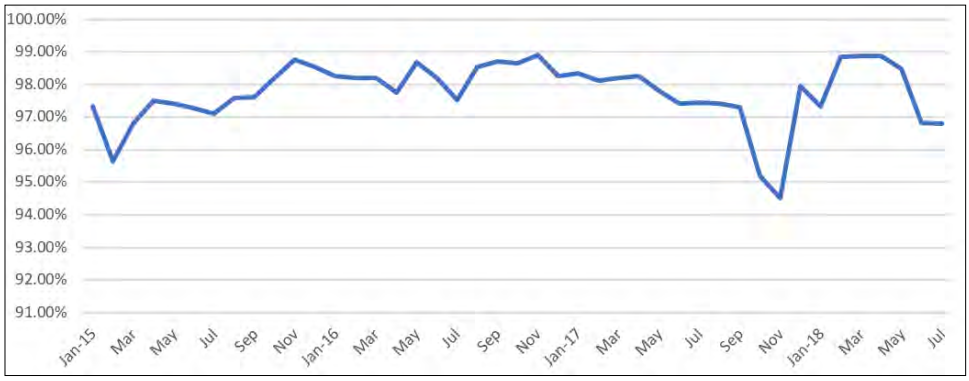
A common industry basis for measuring network performance calculates numbers of packets not received versus totals sent (packet loss rate). An increased loss rate during a target period can indicate failure to receive a meter's usage registrations needed for billing its customer. The next chart depicts AMI network packet loss from 2015 through July of 2018. These data show no pattern of materially changed packet loss rates across the six-month period of focus. Packets not received get resent; when resending does not succeed, no usage registration for that point in time is secured.

AMI Network Packet Loss Rates



Minutes of availability offers another measure of network performance. CMP tracks network availability on a daily, monthly, and annual basis - - summarized in the next chart since 2015. With the exception of a dip in availability during the October 30th storm, CMP's AMI network availability has provided 95 percent and higher availability since 2015.

AMI Network Minutes Available



2. AMI Network Security

CMP developed an AMI Cyber Security Plan as a condition of its Department of Energy Smart Grid Investment Program grant. The Department also required vulnerability assessments to evaluate network reliability against the Cyber Security Plan. Network design protects against unauthorized access, and ensures secure data transfer and storage. The Plan governs monitoring and protection of the network. CMP has implemented control, monitoring, and testing activities that we reviewed, but do not report them here, given their highly confidential nature.

Cellular modems provide communications to a small number of AMI devices. CMP has observed two instances of targeting of their modems by malware. Management removed both modems immediately, and switched to a version offering additional firewall controls. The new brand has not been involved in any malware threat bulletins to date. Management has observed no other instances in AMI network devices, metering data, or smart meters experiencing intrusion, breach, hacking, denial of service attacks, cyber extortion, or other cyber tampering.

3. Testing Head End System to SmartCare to Printed Bills Performance

a. Completing End-to-End Testing

Our process for end-to-end testing of billing accuracy began with the meter accuracy and the meter-to-Head End communications addressed above. The remainder of that testing took us from Head End data to actual bills, which CMP maintains in the form of PDF files depicting actual bills as sent to customers. As described earlier, a comparative wealth of data exists upon reaching the Head End System. We took advantage of the millions of measurements available to develop a series of tests, many of which involved nearly all AMI meters for every month of the period from November 2017 through April 2018. These tests sought to validate that meter data collection, storage, and transmission occur accurately, completely, timely, and consistently.

We also tested another system, the Itron Field Collection System that CMP uses to manually collect meter reading data for the 7,400 meters not part of the AMI network (as some customers have opted out of AMI metering).

The specific tests performed addressed each recording of usage information and its transmission from the meter to SmartCare, where billing calculation occurs. The goal was to ensure that the data transmitted to and received by each component remained complete and unchanged, in order to ensure that usage recorded initially was the same usage driving billing calculation, absent a justified basis for correcting it for use in billing. The tests began with (the first of them described above) sought to:

1. Validate accurate transmission and retention of data collected from the same sample of digital smart meters tested for accuracy (see Chapter Two) in the Head End System
2. Match the data as captured in the Head End System with corresponding data in the Meter Data Management System
3. Match the data as captured in the Meter Data Management System to the SAP SmartCare system data for billing
4. Validate accurate transfer of analog meter data from the Field Collection System to the SAP SmartCare system for billing.

b. Testbed Design

We worked with CMP to create a series of extract files that contained all data elements and billing determinants needed for each bill produced during the period from November 1, 2017 through April 30, 2018. We tested the extracting process for integrity; *i.e.*, to provide assurances that the data extracted precisely mimicked that of the systems from which extracted. We then merged the files extracted (from SAP SmartCare, the Meter Data Management System, SAP Business Warehouse, Head End System, and Field Collection System) to create a master testbed that would allow us to perform end-to-end testing between the Head End System and SmartCare.

Extract file creation followed this general path:

- For Field Collection and Head End System, mine the data from output files created daily to move reading data from the Field Collection System to Head End System.
- For the Meter Data Management System and SmartCare, run queries to output data to files.

- Merge the data from these sources to create one row per bill, using SQL queries written specifically for this task
- Add all bill determinants and information needed for billing
- Separate the master, merged file into a series of files manageable for analysis after import into our database
- Take some ancillary extracts from SmartCare in order to provide other data needed to calculate the bill.

These data extracting, merging, and subdividing processes ended up producing a testbed of more than 4.3 million metering and billing records (roughly one per meter per month) for analysis and validation.

4. Tests of Extracted Data Accuracy

To ensure that the extract files provided mimicked the same data resident in CMP's source systems (SAP SmartCare, Meter Data Management System, SAP Business Warehouse, Head End System, and Field Collection System), we verified accuracy through a series of statistically-driven verification tests:

- Match extract data to Head End System source data
- Match extract data to Meter Data Management System source data
- Match extract data to Field Collection System source data
- Match extract data to SAP SmartCare System source data.

a. Head End System Extract Validation Test

Test Results: 100% verification of testable instances

To verify the validity of the data extraction process, we pre-identified 400 randomly selected sample accounts from our system extracts, targeting specific billing months, to compare with corresponding entries in the Head End System, from which our extracts were taken. We did not pre-identify them to CMP. Sitting with CMP personnel, we asked them to query the system to bring up the sample accounts one-by-one. We examined the system records as they were pulled-up on screen to verify that the data provided in the test extract matched the information the source system produced. We selected a fairly large sample size of 400 because we expected to encounter instances in which bills would not have been produced, for a variety of valid reasons, for a specific account during a specific month in our test period (November 1, 2017 through April 30, 2018). We validated Head End System entries for 355 instances. The remaining 45 accounts had no bill for the month that our random selection process generated. That number accords with our expected level of unavailable sample data.

b. Meter Data Management System Extract Validation Test

Test Results: 100% verification of testable instances

We similarly created and tested a random sample of 400 different accounts from our extracts, again targeting specific billing months, to compare with corresponding entries in the Meter Data Management System. We again recognized in advance that a significant number of samples would not prove verifiable. We tested the match between the extract data we obtained and the data in the Meter Data Management System, gained through real time access to the system. We matched the

data for 367 accounts. We could not test 33 because no bill for the account occurred in in the month targeted in the random sample.

c. Field Collection System Validation Test

Test Results: 100% verification of testable instances

The Field Collection System collects meter data primarily from analog meters and from meters whose customers have opted out of AMI smart meter measurement. The stand-alone Field Collection System uploads files directly to the SAP SmartCare system for billing. The Head End and Meter Data Management Systems do not receive the Field Collection System data. We gained onsite access to the Field Collection System source files. We randomly selected approximately 1,000 accounts from our extracts, using targeted billing months, to compare with corresponding entries in the Field Collection System source files. As with the previous tests, we sought to verify that our extract data matched that of its source, in this case the Field Collection System. We used a large sample size in this instance to address the fact that CMP reads bi-monthly for the many of its analog or manually read meters.

We did not test 568 accounts because their meters were not read during the target month and readings were not available to test, a condition we expected. These exclusions left 432 instances, 100 percent of which showed a match between our extract and the Field Collection System.

d. SAP SmartCare System Validation Test

Test Results: 100% verification of testable SmartCare and PDF bill archive instances

We followed a similar process of randomly selecting and then presenting more 430 instances from our extracts for cross checking against entries (viewed live) from the systems used to generate the extracts. This effort tested a number of data points from the testbed we created from CMP system extracts. The data points tested here included the following SAP SmartCare system entries: Delivery Charge, Supply Charge, Current Meter Reading kWh, Current and Previous Meter Reading Dates, Previous Meter Reading kWh, Billed Days, and Total kWh Usage. We also examined archived PDFs of actual bills issued for each target account to ensure that each bill accurately reflected and used data in the SmartCare system.

We eliminated 24 of the 430 accounts reviewed because there was no bill for the month targeted by our random selection process. We verified a match between the entries in our extracts and the SmartCare and archived bill for all of the remaining 406 accounts.

5. Assessment of Systems Performance

The validation testing described in the preceding sections led us to conclude that we had a highly accurate collection of data from which to test the accuracy, completeness, and timeliness of information receipt, storage, retrieval, and transmission between the Head End System (or the Field Collection System for non-AMI meter reads) and final customer bills, as recorded in the PDF archived bills actually sent. We then conducted the following examinations:

- Validate that data stored in the meter is accurately transmitted to the Head End System
- Validate that AMI meter data is accurately transmitted from the Head End System to the Meter Data Management System and finally to SmartCare for billing.

- Validate that manually (non-AMI) collected meter data is accurately transmitted from the Field Collection System to the SmartCare for billing.

We examined all available records in our testbed (3.8 million records) for matches between:

- Meter readings stored in the Head End and in the Meter Data Management Systems
- Meter readings stored in the Meter Data Management System and SmartCare
- Meter readings stored in the Field Collection System and SmartCare

We created calculated fields in our testbed to compare meter readings among these four systems, thereby enabling the system to determine if the readings matched.

We found in our testing of matches between Head End and Meter Data Management System values that 99.2 percent of Head End System meter readings matched Meter Data Management System stored meter readings. The next two tables summarize the exceptions and average variances in kWh found by class of customer.

Summary of Head End System/SmartCare Mismatches

Customer Class	Rounding Difference	SAP < HES	HES = 0	Total
Residential	829	27,411	794	29,034
Small	107	1,919	49	2,075
Total	936	29,330	843	31,109

Average Sizes of HES Variances (kWh)

Customer Class	Variance
Residential	24.8 kWh
Small General Service	28.5 kWh
All Classes	25.0 kWh

The causes of the 0.8 percent mismatches between the Head End System and SmartCare were:

- 0.02% due to rounding differences.
- 0.8% from instances where the SmartCare meter reading exceeded the Meter Data Management stored reading. Variances between the readings for this category of exception averaged 33.4 kwh.
- 0.02% of the mismatches showed Meter Data Management System readings of zero, but SmartCare recorded readings of non-zero values. This phenomenon indicates data inadvertently left out of our test extract when CMP pulled data from the source systems.

In testing matches between Meter Data Management System and SmartCare values, we found that 99.2 percent of Meter Data Management System meter readings matched SmartCare stored meter readings, when evaluating all records. The next tables summarize the exceptions and average variances found by customer class.

Summary of Meter Data Management/SmartCare Mismatches

Customer Class	Rounding Difference	SAP<MDM	MDM=0	Total
Residential	831	27,219	794	28,844
Small GS	124	2,291	49	2,464
Medium GS	15	389		404
Intermediate GS		7		7
Total	970	29,906	843	31,719

Average Sizes of MDM Variances (kWh)

Customer Class	Variance
Residential	22.0 kWh
Small General Service	78.9 kWh
Medium General Service	646.0 kWh
Intermediate General Service	32.6 kWh
All Classes	33.4 kWh

The causes of the less than one percent mismatches between the Meter Data Management System and SmartCare were:

- 0.02% from rounding
- 0.8% where the SmartCare meter reading exceeded the Meter Data Management stored reading (variances between the readings for this category of exception averaged 33.4 kwh)
- 0.02% showed Meter Data Management System readings of zero, but SmartCare recorded readings of non-zero values (this phenomenon indicates data inadvertently left out of our test extract when CMP pulled data from the source systems).

In testing matches between the Field Collection System and SmartCare values, we found that 99.2 percent of Field Collection System meter readings matched SmartCare stored meter readings, when evaluating all records. The next tables summarize the exceptions and average variances found by class of customer.

Summary of Field Collection System/SmartCare Mismatches

Customer Class	Rounding Difference	SAP<FCS	FCS=0	Total
Residential	831	27,219	794	28,844
Small GS	124	2,291	49	2,464
Medium GS	15	389		404
Intermediate GS		7		7
Total	970	29,906	843	31,719

Average Sizes of FCS Variances (kWh)

Customer Class	Variance
Residential	22.0 kWh
Small General Service	78.9 kWh
Medium General Service	646.0 kWh
Intermediate General Service	32.6 kWh
All Classes	33.4 kWh

The causes of the less than one percent mismatches between the Field Collection System and SmartCare were:

- 0.02% due to rounding differences.
- 0.8% from instances where the SmartCare meter reading exceeded the Meter Data Management stored reading. Variances between the readings for this category of exception averaged 33.4 kwh.
- 0.02% of the mismatches showed Meter Data Management System readings of zero, but SmartCare recorded readings of non-zero values. This phenomenon indicates data inadvertently left out of our test extract when CMP pulled data from the source systems.

6. Data Storage and Handling Practices

CMP applies only limited procedures to ensure that usage data is stored on the correct date and time in the Meter Data Management System. Management performs only minimal edits and validations on the data transferred from the meter to the Head End and Meter Data Management Systems. The AMI mesh network gathers data from each meter, transferring that data through collectors and gateways to the Head End System. The Meter Data Management System gathers Head End System data daily. The Meter Data Management System functions simply to ensure collection and store the resulting readings by date, performing no validation activities. CMP relies on its SmartCare billing system to validate meter usage data prior to billing. Routines within SmartCare compare meter usage and other billing determinants to identify billing exceptions for any unavailable data or data that exceeds expected thresholds. These billing exceptions must be corrected before billing can be completed.

Such reliance proves effective when meters remain in date and time sync with the AMI Network. The Meter Data Management System stores midnight data collected from the meters. Very few CMP residential meters contain batteries. Those without batteries require time and date resets when re-initialized after a loss of power. The meters depend upon the AMI network to set and keep the correct date and time. However, as Chapter III details, meter clocks cause problems for CMP.

A GE I-210+c meter in fast-clock operation gains 4 hours and 48 minutes in a 24-hour period. Failure to apply special reset procedures will produce readings recorded as ever-advancing times relative to Network time. The minimal editing and validation functioning of the Meter Data Management System will cause it to store what is really today's usage under a future date. Management has instituted a weekly routine to erase any future-dated meter readings stored in the Head End System so that it cannot be passed to the Meter Data Management System. There remains, however, the opportunity for an advance-dated meter reading to become the basis for a

billing read. We observed such instances in performing our examinations. Moreover, the process to erase future readings has produced gaps in CMP's daily meter read history. In some cases the absence of a reading due to erasure has created an estimated bill or a slightly shorter or longer bill, which can cause customer confusion and lead to complaints.

We observed cases where CMP has used future reads for billing. These cases produce a bill "shorter" than it should, because the meter's clock had moved into the future. Correction of the condition within a month will tend to produce apparent usage (and the corresponding billing) lower in the first month affected, but higher in the ensuing one. Total usage over the two months will be correct, but future dating will have produced a mis-apportionment between the two.

CMP does not store manually read meter data within the Meter Data Management System, collecting it instead through the Itron Field Collection System, then transferring it via MRE files to the SAP SmartCare system for bill preparation. The Field Collection System stores backups of the MRE files for 90 days, after which these daily files are deleted. SAP SmartCare also has a process to save all files that have been sent to or from SAP for 150 days, after which these files are also deleted. As a result, unless CMP saves these MRE files prior to deletion, the original record of the meter usage data is deleted within 150 days. By default, because all MRE data has been sent to SAP SmartCare for billing, SmartCare becomes the system of record for customer meter usage.

CMP's MV90 system, which is used to collect interval-data readings for certain commercial and industrial customers, also sends meter data directly to SAP for billing. However, CMP does load MV90 interval data to Meter Data Management System following billing to facilitate end-user queries.

Ultimately, all meter data used for billing is stored in the SAP SmartCare system and the majority of customer meter data is stored in Meter Data Management System.

The ideal solution is a central repository where consistent, secure, and auditable processes are enforced, and where all users can access accurate and reliable meter data. Additionally, by consolidating reading data from multiple collection systems into Meter Data Management System, consistent validation routines can be set to evaluate AMI performance. Meter Data Management System also provides a comprehensive security structure that includes auditing and tracking of critical business data, as well as logging for operational tasks and modifications of reading data via manual editing, estimation or validation.

C. Conclusions

1. Mesh Network Performance

Our work found the following with respect to the performance of the mesh network in getting meter usage registration data to the Head End System: In summary:

- Read rates remained at high levels during the November 2017 through April 2018 period
- Customers who complained about high bills and those (complaining or not) with high usage or high bills compared with their individual histories were dispersed across the territory
- We could not find localized pockets where the numbers of such customers appeared high

- Data from the few, most recent days retained in the memory of the meters we tested communicated that data accurately to the Head End System.
- CMP's Head End System routinely communications with about 99.8 percent of installed smart meters
- When CMP's Head End System is able to communicate with a smart meter in the field, data is accurately collected from the meter and stored in the Head End system.

For 57 of the 60 meters field tested as part of our sample, we were able to extract several recent days of readings still stored in the meters' limited memory. All those readings matched the corresponding Head End System entries.

We concluded that the mesh network accurately, completely and timely transmits usage data from meters to the Head End System, and has done so since November 1, 2017. We found no basis to attribute inaccurately high bills or a substantially increased number of estimated bills due to packet loss, apart from the need for estimating caused by disruption to the entire CMP delivery system following the October 2017 storm.

2. System-to-System Communication, Storage, and Transfer

We determined that meter usage registration values remained unchanged, complete, and timely as they moved through the systems that get them to SmartCare. We found that 99.8 percent of Head End System meter readings matched Meter Data Management System stored meter readings and 99.77 percent of Meter Data Management System meter readings matched SmartCare stored meter readings.

The small percentage of exceptions (0.23%) between the Meter Data Management System and the SAP billing system and between the Head End System and the Meter Data Management system (.2%) indicate some timing issues (more than one read requested on the same day and only one is used for billing) and a small amount of data that was inadvertently omitted from on our testbed when CMP prepared the data extracts.

This extensive review gave no reason to suspect corruption, incompletion, or delay with respect to the usage registration data from meters (addressed in the preceding chapter) as a material contributor to erroneous customer bills.

3. Data Storage and Handling Practices

Until CMP can address the GE meter anomalies permanently, management should strengthen meter-data storage practices to ensure that meter data is collected and stored on the actual date collected. CMP should investigate adopting Validation, Editing, and Estimation (VEE) standards for handling data within the Meter Data Management System and expand Meter Data Management System storage to include all meter usage readings.

The Itron IEE Meter Data Management System provides the ability to validate, edit, and estimate meter data through the VEE Standards. These standards provide the editing and validation needed to ensure accurate data collection and storage within the Meter Data Management System. CMP

has yet to implement Meter Data Management best practice standards for validation and editing of its AMI smart meter data, but is considering doing so.

Some states have instituted data validation standards for customer usage data, particularly for rates that rely on interval data. In California, VEE standards ensure that interval and monthly meter data is stored accurately and timely. For instance, if time in the meter is within +/- 3 minutes of the time standard, the data passes the Time Tolerance check. If time in the meter is off by more than three minutes but not in excess of 55 minutes, the data passes the Time Tolerance check. The data does not need to be estimated, but the Meter Data Management System must record the fact that the meter's time was off by this amount, in case a later question about the data should arise. If the meter is off by more than 55 minutes, the data fails the time tolerance check and usage must be estimated. The time in the meter must be reset. If the meter fails the time tolerance check after being reset for three consecutive months, the meter must be physically inspected/tested.

V. Accuracy of Billings

A. Background

We used the testbed described in the prior chapter to test billing accuracy and timeliness. Testing and analysis conducted during this task included customers served under residential and under commercial tariffs. It consisted of the following activities:

- Extract and validate SAP data for all metered accounts from all billing cycles during the six-month period to compile usage, rate, days billed, and other billing data for testing (discussed in the previous chapter)
- Test a randomly selected sample of bills to ensure presentment matches SAP stored data and calculations
- Compare data used to calculate actual bills with data from meter databases (discussed in the prior chapter)
- Perform calculations of delivery and supply charges for a variety of rate classifications
- Compare calculated results to SAP billed charges
- Calculate the efficiency of bill issuance, in terms of average days to produce a bill, for all customer groups during all months of our audit period.

B. Findings

1. SAP Data and Bill Testing

Test Results: 100% validation of SmartCare data and of bill presentation testable instances

The four million data points test described in the last chapter included billing data and calculation fields. We tested the billing-related fields extracted from CMP systems for validity using the same general validation methods we applied to other extracted data (also explained in the preceding chapter). We compared extracted data from 430 randomly selected sample billing periods with corresponding archived bills (PDFs) in the SmartCare system to verify an exact match. We sought to match a number of data points from the Test datafile we had compiled from extracts of CMP system data: Delivery Charge, Supply Charge, Current Meter Reading kWh, Current and Previous Meter Reading Dates, Previous Meter Reading kWh, Billed Days, and Total kWh Usage.

We examined archived PDFs of the actual bill issued for each target account to ensure that data in the SmartCare system was appropriately presented on each customer's bill. Given the lack of bills in some months for some accounts, we did not have the ability to validate 24 of the 430 accounts reviewed. We did find a match for all the data tested for all of the remaining 406 accounts. Our validation tests led us to conclude that we had a reliable testbed for use in assessing the billing elements relevant here. Our test of 406 PDF images of bills actually sent to customers also showed a 100 percent match between expected and CMP calculated bills and the PDF images.

2. Comparison of Actual to Expected Billings

We calculated expected billings for rate classifications including: Residential Service, Residential Time of Use, Small General Service, Small General Service Time of Use, Intermediate General Service, Medium General Service, and Large General Service, using the usage measurements whose flow through systems and processes we examined and tested as described in earlier chapters.

Our testbed incorporated over 475 elements needed to generate calculations for matching the bill with those actually produced by SmartCare. Separate calculations apply for delivery and supply charges. Supply charges for some customers adjust more frequently, and all rate classes experienced supply changes that came for many customers in the middle of billing cycles, thus requiring proration of supply charges. Initial and final bills also require proration of service charges and in some cases demand charges. Other factors rightfully cause variances between our calculated amounts and those eventually billed.

We prepared testbed fields using billing determinants required. We used them to calculate expected delivery and supplier charges for each bill. We compared our calculated, "expected" bills to those CMP issued. We excluded records with cancelled/reversed billings (59,001) and accounts with multiple meters or accounts billed together (189,646 records). Understandably, first applications of our calculations to 8 million billing determinants (two for each bill - - delivery and supply) produced a large numbers variances with actually billed amounts. We reviewed exceptions with the Company, pulled and examined sample customer bills, assessed explanations offered, and adjusted calculations or supporting data for reasons we found valid. For instance, when calculating delivery charges we found CMP includes "other charges" within the delivery charge. To match correctly, we were required to account for these other charges in our calculated delivery charge. This iterative process reduced the variances to those presented in the next table summarizing the results of tests to evaluate the accuracy of delivery and supply charge calculations.

Remaining Bill Exceptions

Bill Portion	Total Bills	Exceptions		Exception Dollars	
		Number	%	Total	Per Each
Residential					
Delivery	3,272,999	4	0.0%	($21)	($0.38)
Supply	3,272,999	3,767	0.1%	$1,933	$0.51
Total Residential Variance				$1,912	$0.51
Small General Service					
Delivery	326,565	9	0.0%	($230)	($25.56)
Supply	326,565	1,509	0.5%	$9,148	$6.06
Total SGS Variance				$8,918	$5.87
Medium General Service					
Delivery	71,953	35	0.0%	$6,824	$194.97
Supply	71,953	2,706	3.8%	$17,969	$6.64
Total MGS Variance				$24,793	$9.05
Intermediate General Service					
Delivery	1,449	0	0.0%	$0	$0
Supply	1,449	6	0.4%	($1,341)	($223.51)
Total IGS Variance				($1,341)	($223.51)

Large General Service					
Delivery	321	0	0.0%	$0	$0
Supply	861	6	0.7%	($13)	($2.17)
Total LGS Variance				($13)	($2.17)
Total All-Customer Variance			0.2%	$34,269	($210.25

We excluded Large General Service Transmission and Sub-Transmission rates from the Delivery Charge calculations. The total number of billing variances that remain number less than one percent. Work with the Company has resulted in a reduction in the number of exceptions. Continuing this work would likely reduce their number further. For example, we discovered atypical proration applicable to a group of accounts that experience a supplier rate change in the middle of a billing period accompanied with an interim meter reading. CMP continues to research the bills involved to review the proration and has confirmed that amounts billed are accurate on the research performed to date.

Moreover, while the level of variance remaining shows billing exceptions to be very small, and customer-favorable on a net basis, the preceding table shows a range of impacts among classes, and not all in the same direction. The tables presented in an appendix to this chapter break the classes shown in the preceding table down further, underscoring the differential impacts of our remaining variances on rate classes.

C. Conclusions

Our iterative matching process between all the delivery and supply determinants of all bills processed by the SmartCare system for November 2017 through April 2018 and our calculation of those two determinants has produced a match level of 99.9 percent for delivery and 99.8 percent for supply. The total magnitude of the dollars associated with those variances is small. Exceptions proved very low for delivery charges, but higher for supplier charges. The number of exceptions for residential customers proved particularly small both in number and in net impact in both delivery and supplier charges.

It is likely that a continuing iteration with management will further reduce the number of variances, but we believe it is already clear that billing error does not form a material contributor to erroneous bills during the November 2017 through April 2018 period.

However, we have established that some of the variances in fact reflect billing errors that have already been corrected through a cancel/rebill process. CMP should complete the process of reconciling our calculations to amounts actually billed to ensure that any billing errors are appropriately addressed. CMP has begun to do so.

The matching process for the eight million billing determinants involved for customers during the November 2017 through April 2018 period proved very complex, for understandable reasons. Our first matching process generated many more exceptions, with explanations from and iterations with management succeeding in reducing them to their current total levels of less than one percent.

Chapter V Appendix: Delivery and Supply Charge Testing Results by Customer Type and Rate

Delivery Charge Testing Results by Customer Type and Rate

Residential Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
Residential Service	3,241,050	100.0%	4	0.0%	($21)
Load Management Service	1,258	100.0%	0	0.0%	$0
Residential Time of Use	30,691	100.0%	0	0.0%	$0
Small General Service Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
Small General Service	323,692	100.0%	9	0.0%	($230)
SGS Time of Use	2,873	100.0%	0	0.0%	$0
Medium General Service Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
MGS Primary TOU	132	100.0%	0	0.0%	$0
MGS Primary Service	1,035	98.8%	12	1.2%	$1,080
MGS Secondary	69,236	100.0%	23	0.0%	$5,744
MGS Secondary TOU	1,052	100.0%	0	0.0%	$0
Intermediate General Service Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
IGS Primary	347	100.0%	0	0.0%	$0
IGS Secondary	1,102	100.0%	0	0.0%	$0
Large General Service Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
LGS Primary TOU	294	100.0%	0	0.0%	$0
LGS Secondary TOU	27	100.0%	0	0.0%	$0
Total					
Total	**3,672,789**	**100.0%**	**48**	**0.001%**	**$6,573**

TOU – Time-of-Use

Supply Charge Testing Results by Customer Type and Rate

Residential Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
Residential Service SOP	2,723,848	99.9%	2,814	0.1%	$(673)
Residential Service CEP	517,019	99.9%	681	0.1%	$ 2,792
Load Management Service	1,258	99.0%	12	1.0%	$(44)
Time of Use SOP	26,240	99.9%	26	0.1%	$(627)
Time of Use CEP	4,451	94.7%	234	5.3%	$485
Small General Service Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
Small General Service SOP	240,139	99.9%	185	0.1%	$ (1,450)
Small General Service CEP	89,579	98.5%	1,309	1.5%	$ 10,280
SGS Time of Use SOP	1,308	100.0%	0	0.0%	$ -
SGS Time of Use CEP	1,565	99.0%	15	1.0%	$318
Medium General Service Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
MGS Primary TOU	132	100.0%	0	0.0%	$ -
MGS Primary CEP	496	97.0%	15	3.0%	$(439)
MGS Primary SOP	581	69.9%	175	30.1%	$(840)
MGS Secondary SOP	37,389	93.6%	2,406	6.4%	$ 1,268
MGS Secondary CEP	32,303	99.7%	101	0.3%	$ 17,937
MGS Secondary TOU	1,052	99.1%	9	0.9%	$43
Intermediate General Service Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
IGS Primary SOP	66	95.5%	3	4.5%	$469
IGS Primary CEP	282	99.3%	2	0.7%	$2
IGS Secondary SOP	89	97.8%	2	2.2%	$ (1,258)
IGS Secondary CEP	1,013	99.8%	2	0.2%	$(85)
Large General Service Accounts					
Rate Class	**Test Size**	**% Correct**	**# Exceptions**	**% Exceptions**	**Total Variance**
LGS Primary TOU CEP	293	99.3%	2	0.7%	($156)
LGS Primary TOU SOP	1	0.0%	1	100.0%	($4)
LGS Secondary TOU CEP	27	100.0%	0	0.0%	$0

LGS Subtransmission TOU SOP	62	100.0%	0	0.0%	$0
LGS Subtransmission TOU CEP	285	100.0%	0	0.0%	$0
LGS Transmission TOU CEP	132	100.0%	0	0.0%	$0
LGS Transmission TOU SOP	61	95.1%	3	4.9%	$147
Total					
TOTAL	**3,679,671**	**99.8%**	**7,997**	**0.2%**	**$28,165**

TOU – Time-of-Use
SOP – Standard Offer Price
CEP – Competitive Electric Provider

VI. Analysis of Customer Usage

A. Background

1. Reasons for Examining System-Wide Usage Patterns

We examined customer usage across the CMP system during the November 2017 through April 2018 period. We reviewed total usage, and examined residential and general-service customer usage separately. We looked at usage as a function of daily heating degree days - - a major factor driving electricity use, particularly in cold regions with significant customer use of electricity as a heating source. We undertook this review seeking to determine if, and if so, how weather contributed to higher than normal usage. One degree day represents a difference of one degree in mean daily outdoor temperature. Thus, for example, a day with an average temperature of 32 would have a Heating Degree Day (HDD) value of 33 if 65 degrees serves as the mean outdoor temperature for comparison. Higher degree days mean more heating requirements and therefore presumably more usage.

2. Method for Examining the Patterns

We secured five years of daily CMP residential and general service customer usage data and daily degree day information for each of those five years. We then calculated for each day the ratio of usage to degree days. This ratio allowed us to compare November 2017 through April 2018 usage without distortion due to changes in customer population. Usage patterns vary across days of the week. We therefore aligned the days from each of the five years to match days of the week for the November 2017 through April 2018 period. For example, the first day of this period, November 1, 2017, fell on a Wednesday. November 1, 2016, fell on a Tuesday; therefore, we chose November 2, 2016, as the first day of our corresponding period. We did the same for the earlier of our five years.

For each of the days from November 2017 through April 2018, we looked through the prior four years to find the day with the closest number of degree days. The goal was to compare the usage to degree day ratios for the most weather-comparable day of the prior four years with the corresponding day from the November 2017 through April 2018 period. A reasonably close alignment of the ratios would provide an indicator that usage on the day from this recent period was in line with expectations based on recent-year experience on the same day of the week and having the closest possible alignment of degree days.

We compared the days against each other in absolute terms and with respect to the differences between them in degree days. For example, if the first, raw comparison showed a materially higher ratio, the second comparison would indicate whether colder weather might explain it. We performed the analysis day-by-day to ensure granularity, but do not believe that looking for daily differences is meaningful. There is too much variability in day-to-day usage across a system to make such an analysis helpful. For example, consider two mid-February Tuesdays, one with schools closed for a snow day and the other not.

B. Findings

We began with two very broad comparisons of usage over the period for which we gathered usage and degree-day data:

- A comparison of monthly usage-to-degree day ratios (we termed this the "***HDD Ratio***") for November 2017 through April 2018 (we termed this the "***Study Period***") with the same ratios averaged for the corresponding historical months over 2013 – 2017 (we termed those five years the "***Comparison Period***")
- A comparison of the HDD Ratio for the Study Period with the same ratios for the corresponding months of 2016 and 2017.
- We performed these comparisons separately for residential and general service usage. We performed the second comparison for two reasons:
    - To the extent overall usage patterns have changed over time, a comparison with the most recent year would tend to reflect that evolution
    - To the extent that recent customer concern about high bills was triggered by comparison with the most recent historical data, use of November 2016 through 2017 would highlight differences from the more recent period.

The next two tables show the results of these comparisons. The chart shows:

- Overall, the residential Study (2013-2017 results) and Comparison (see Study Period Day versus Comparison Day Usage chart) HDD Ratios of 104.1 percent were essentially the same
- Residential total usage exceeded HDDs by essentially the same amount (3.3 versus 3.0 percent) for the comparison to 2013-2017 average
- The Study and Comparison HDD Ratios for GS customers were essentially the same

Overall Usage Comparisons

Month(s) Compared to	HDD Ratio		HDDs	Total Usage	
	Res.	GS		Res.	GS
Study-Period Month versus Average Comparison Period Month					
vs. Avg. 2013-17 Nov.	109.1%	104.3%	95.2%	103.8%	99.3%
vs. Avg. 2013-17 Dec.	90.2%	83.6%	119.6%	107.8%	100.0%
vs. Avg. 2013-17 Jan.	100.7%	95.2%	107.8%	108.5%	102.6%
vs. Avg. 2013-17 Feb.	117.4%	120.1%	82.0%	96.2%	98.4%
vs. Avg. 2013-17 Mar.	113.6%	118.0%	86.3%	98.0%	101.8%
vs. Avg.2013-17 Apr.	93.4%	82.6%	112.2%	104.9%	92.8%
vs. Avg. 2013-17 Total	100.4%	95.6%	103.0%	103.3%	98.4%
Study Period Month versus Corresponding 2016 -2017 Month					
vs. 2016-17 Nov.	93.2%	91.1%	113.9%	106.2%	103.7%
vs. 2016-17 Dec.	92.9%	90.6%	113.0%	105.0%	102.4%
vs. 2016-17 Jan.	92.2%	85.9%	122.5%	113.0%	105.3%
vs. 2016-17 Feb.	108.8%	110.5%	92.2%	100.3%	101.9%
vs. 2016-17 Mar.	111.3%	115.7%	85.8%	95.5%	99.3%
vs. 2016-17 Apr.	82.4%	78.9%	127.0%	104.7%	100.3%
vs. 2016-17 Total	97.2%	95.4%	107.1%	104.1%	102.2%

Other observations we made from the data include:

- The Study Period and the Comparison Period residential HDD ratios are nearly identical despite the higher Study Period HDDs.

- The Study Period HDD Ratios are actually lower than those of the corresponding months of the prior year.
- General Service customer usage and HDD Ratios are comparatively low in the Study Period.

1. The Use of "Comparison Days"

From month to month, the charts display significant variability. We went on to analyze day-to day patterns to see if they would shed light on the question of why customer concern and complaints reached such high levels over the Study Period.

For each day from November 1, 2017, through April 30, 2018, we identified the day from the previous four years with the closest number of HDDs. Our day-of-the week alignment process produced start dates for each year from 2013 through 2016. November 1, 2017 was the first Wednesday of the month. We chose the first Wednesday for each of the other years:

- Wednesday November 6, 2013: HDD=25
- Wednesday November 5, 2014: HDD=11
- Wednesday November 4, 2015: HDD=15
- Wednesday November 2, 2016: HDD=13.

Our "Actual Day" of November 1, 2017 had 23 HDDs. The closest value among our other first Wednesdays was November 6, 2013, with its 25 HDDs. We selected a similar list of Comparison Days for each of the remaining Actual Days of the Study Period - - November 2, 2017, through April 30, 2018. We found some cases where multiple Comparison Period days had identical HDDs that proved the closest to our Study Period Day. In those cases, we averaged usage for those days for use in this analysis.

2. Actual Day and Comparison Day HDD Ratios

We then compared HDD Ratios for each Actual Day of the Study Period with the HDD ratio of its Comparison Day. The following table summarizes the results of that comparison, and others. The table shows monthly results and Total November - April result of comparing:

- Residential Use to HDD Ratio on the Actual Day versus its Comparison Day
- General Service Use to HDD Ratio on the Actual Day versus its Comparison Day
- HDDs on the Actual Day versus its Comparison Day
- Residential Use on the Actual Day versus its Comparison Day
- General Service Use on the Actual Day versus its Comparison Day.

Study Period Day versus Comparison Day Usage

Month	HDD Ratio Res.	HDD Ratio GS	HDDs	Residential Usage	GS Usage
November	108.0%	103.1%	95.5%	103.2%	98.5%
December	94.9%	90.6%	110.1%	104.5%	99.8%
January	101.1%	92.9%	109.7%	110.9%	101.8%
February	107.1%	108.4%	93.1%	99.7%	100.9%
March	97.2%	93.8%	101.9%	99.0%	95.6%
April	97.2%	86.0%	107.7%	104.7%	92.6%
Total	100.4%	95.0%	103.4%	103.8%	98.2%

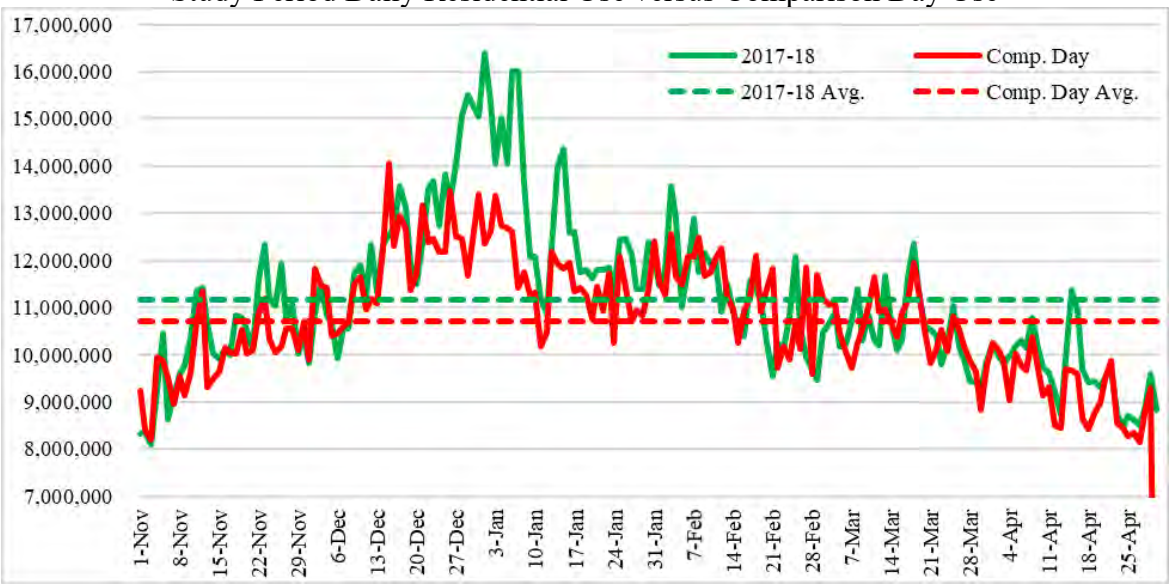
The use of daily information shows that differences in usage between the Actual Days and their corresponding Comparison Days conform closely to the differences in HDDs between them. For example, outside of November and December, the biggest difference between the ratios of HDDs and residential usage between the Actual Days and Comparison Days is 6.5 percent in February (93.1 percent for HDDs versus 99.7 percent for usage). Moreover, the differences in November and December (which included the first CIS post-go-live month and the December holiday period) came close to canceling each other out.

Month	HDD Ratio	HDDs	Difference
Nov.	108%	96%	13%
Dec.	95%	110%	-15%
Average	100%	103%	-3%

3. Daily Actual Day versus Comparison Day Usage

The next graph plots Residential use on Actual Days from the Study Period versus Usage on their Comparison Days. The dotted lines show averages for the period, demonstrating the higher residential use in the Study Period - - at a percentage level (3.8 percent higher) conforming to the differences in degree days between the Actual Days and their Comparison Days (3.4 percent).

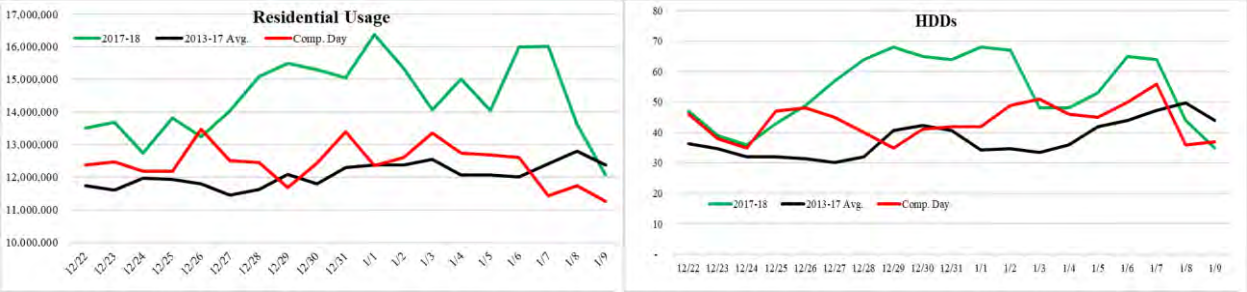
Study Period Daily Residential Use versus Comparison Day Use



4. The Christmas-Period Deviation

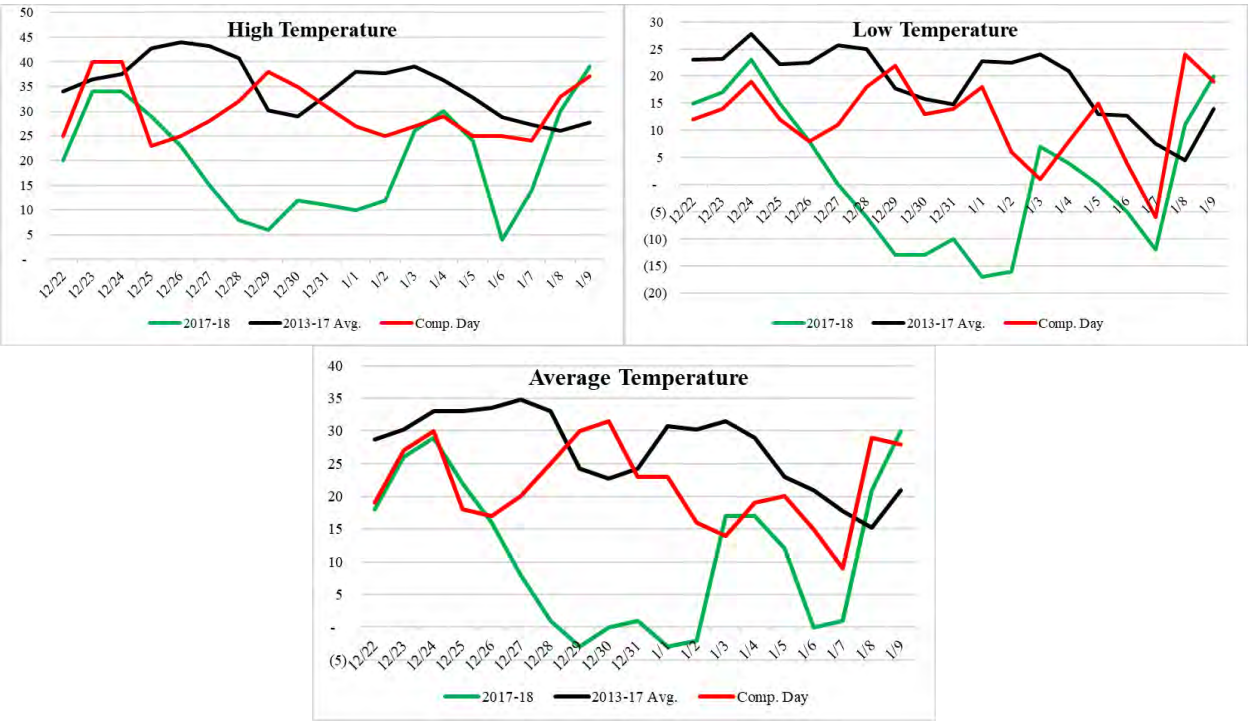
Apart from an anomalous period beginning in late December, the chart above shows strong correlation between actual usage on the Actual Days of the Study Period and the usage on the Comparison Days with the closed HDD values. We charted usage and HDDs from December 22 to January 9, as shown in the following chart.

December 22 -January 9 Actual and Comparison Day Usage



The charts show colder weather for the Actual Days, when compared to both Comparison Days (either the average for the whole historical period or for the chosen individual Comparison Days). Moreover, both the low and the high temperatures for the Actual Days (see charts below) were significantly lower for an extended stretch, thus tending to increase usage. Between this clear difference and the "noise" introduced into the data by which days reflected the holiday period best, we determined that the one period of significant imbalance in our base Actual Day to Comparison Day usage did not comprise an indicator of measurement error.

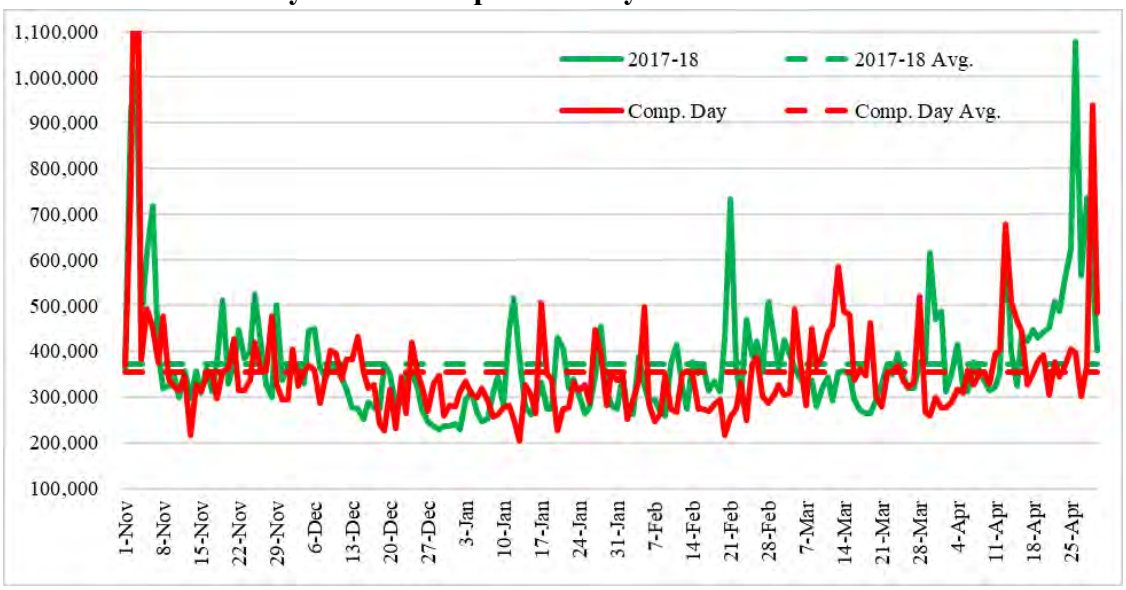
December 22 -January 9 High, Low, and Average Temperatures



5. Ratio of Usage to HDDs

Our last comparison charted the daily residential HDD Ratios (residential use divided by the day's HDDs), and compared those ratios of the Actual Days of the Study Period versus their Comparison Days. The next chart shows a strong correlation.

Actual Day versus Comparison Day Residential HDD Ratios



C. Conclusions

Our examination of usage in total and as a function of heating degree days found total customer usage on the CMP system during the period from November 2017 through April 2018 at a magnitude consistent with ratios and volumes experienced over the preceding years, beginning with 2013. The amount by which usage exceeded historically derived ratios match the amount by which weather during the period was colder.

We used ratios that accounted for changes in customer numbers, and we matched usage information as best we could to days of the week to prevent mismatching weekday with weekend days, where usage patterns differ. We found only small differences from what prior usage patterns on days with similar degree day values would suggest. Inherent variability in usage from year-to-year, month-to-month, and even day-to-day mean that no perfect correlation can be drawn. Nonetheless, we attribute high bills this past winter season to cold weather and supply rate increases.

VII. Customer Information System Implementation

A. Background

We examined whether unexpected consequences of Customer Information System (CIS) implementation and post-go-live operation had an impact on billing and customer interaction in November 2017 through April 2018 period. We focused on management's identification of and responsiveness to any issues or concerns affecting billing or customer interaction.

Well-managed CIS implementation projects center around a customer-service delivery vision expressing clearly defined objectives and a full understanding of how the CIS solution will support that vision. Successful projects: (a) implement and test the solution's design, (b) conduct business-process assessment and re-engineering, (c) plan hardware and software configurations in detail, (d) convert existing data to enable its successful processing in the new system, (e) define and apply go-live acceptance criteria, (f) conduct pre-go live testing to ensure satisfaction of those criteria, (g) train system users, and (h) create and execute post go-live transition plans. Careful attention to each ensures a smooth transition executed with minimum adverse customer impacts.

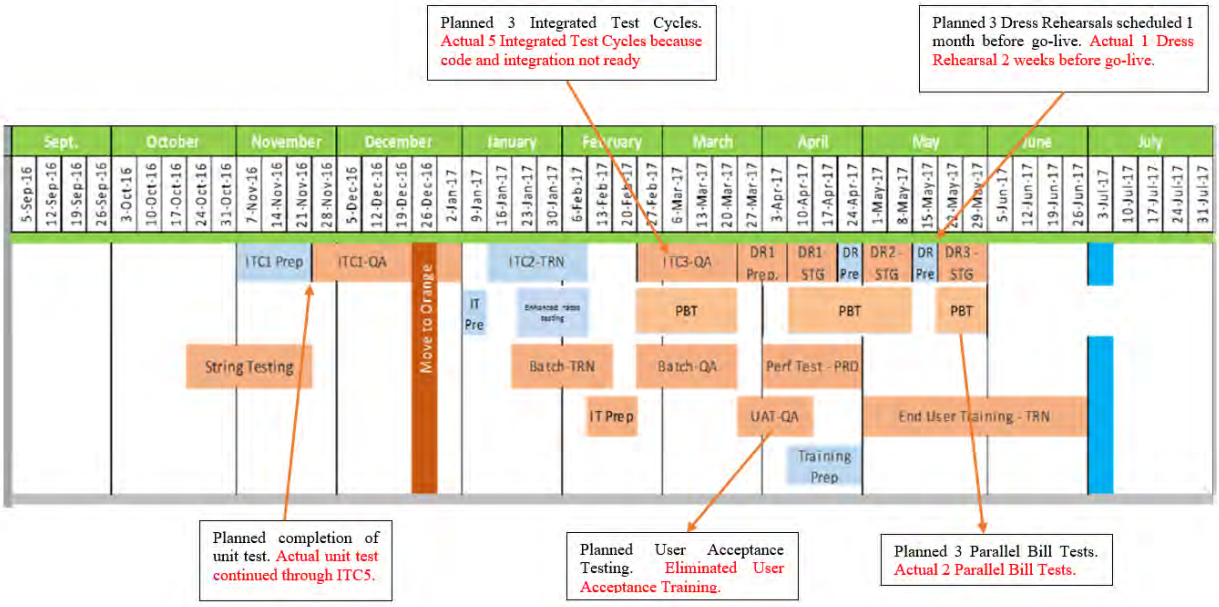
Important late-stage preparation for go-live includes assessment of the system and its user organizations and resources including end user training, user acceptance testing, a "Go/No-Go" decision to go live and data migration to production. The focus of post-go live activities involves structured and aggressively executed efforts to identify, monitor, and resolve issues deferred for resolution until after go-live. Management also needs to continue comprehensive efforts to identify further issues post go-live, in order to reach steady state operation as quickly and efficiently as practicable, while managing and mitigating transitory impacts on customers.

B. Findings

1. Pre-Production Testing as Planned versus Conducted

CIS implementation projects rely heavily on pre-operation testing to ensure delivery of the capabilities and functionality of the CIS solution as expected. Extensive testing and resolution of the defects identified form key elements in successful CIS implementation. CMP planned extensive testing, which the next chart summarizes, to support its planned July 2017 go-live date (eventually delayed to October 30, 2017).

CMP's CIS Testing Plan



CMP management held to a planned go-live date of October 30, 2017 by compressing its planned timelines and overlapping critical testing phases. The approach changed from the more cautious intended approach of ensuring completion of planned tests to one that allowed only such testing as fit into the ever-compressed time remaining before the end of October 2017 and as the remaining budget permitted.

Unduly restricted testing leads to two major adverse impacts. It tends to produce lingering software defects to be discovered after go-live. Insufficient testing also places the customer service team operating the system at a disadvantage. They lose the advantage of foregone pre-production testing activities that comprise a significant element of their training and learning, and contribute to their software knowledge. Impaired software understanding can lead to inadequate documentation of new work procedures and insufficiently trained end users. Post-production discovery of defects then creates more than normal confusion, compounding both corrective efforts and the ability of the operating team to maintain a sufficient flow of effective day-to-day work.

A later section of this chapter describes staffing insufficiencies experienced by CMP. A lack of functional (also called "business") resources further impaired pre-production testing activities. CMP's functional staff had both testing and training responsibilities under the project. As progress lagged during later stages, the project governance group addressed the lack of availability of functional resources by moving functional staff's unit and integrated testing responsibilities to service company (Avangrid Information Technology) personnel and consultants supplied by the third party serving as project integrator. The governance group sought to avoid schedule delay through the employment of "*Limited volume/scenario testing of key functionalities, Unit/Integration testing via very small volumes.*"

Efforts to press toward the October go-live date reduced the depth of testing, produced a minimal number of test scenarios for key business processes (*e.g.*, SimplePay budget billing), and compromised regression testing. Personnel provided by the project integrator performed

conversion, integrated and parallel testing, reducing deeper testing by the eventual process owners and operators. The project integrator reported in July 2017 that:

> *The delivery of the scope, from a development and solution completeness, and more importantly, from a testing perspective, is behind where a project of this size and complexity should be for a go live in early September. Of particular concern are the critical interfaces and integrations that are not fully tested. Data conversion reconciliation tools are currently in unit testing and have not been fully deployed. Data validation efforts have been lower than typical for a project of this scope, particularly given the customer impacts of this project. Client has limited business resources to deploy to the effort, limited testing time and completion, as well as business readiness preparations. The limited business users involved in the project can create a situation where it becomes difficult to support the end user community at go live with super users and SMEs.*

Management addressed the threat to the October 30 go-live date through the high-risk approach of permitting the phases of Unit Testing, Integration Testing, and Parallel Bill Testing to overlap. One result was that testing had to be executed on processes still under development; *i.e.*, with code changes in process to remediate identified defects, subsequent test phases relying on those changes were being executed. Some degree of overlap can occur on large-scale projects of this type, but management should require, which CMP did not, at least one clean round of Integration Testing prior to proceeding to User Acceptance Testing, or the substitute Parallel Bill Testing employed by CMP in developing SmartCare.

The original plan included 30 weeks of testing, but ultimately witnessed only 17 weeks conducted in overlapping test phases. We excluded from this calculation the weeks for ITC1 and 2 testing. While reported as beneficial for learning, that testing did not meet the testing objectives. The project schedule also included a mandatory code freeze, but project management did not enforce it. Multiple code changes were released right up to the system launch, without testing to assess the impact of the fixes on previous testing.

Management also eliminated User Acceptance Testing. User acceptance testing (UAT) employs business end users to validate that intended business requirements have been appropriately met. Status reports show UAT last showing up as an activity scheduled from June 19, 2017 to July 7, 2017 in the June 16, 2017 report. Management stated that it incorporated such testing into ITC4 and 5. Best practice schedules UAT later, after greater integration and with capabilities working operationally. The UAT environment is not conducive to CMP's approach. Conducting UAT properly would have taken longer than CMP allowed in its compressed testing schedule.

The CMP SmartCare development process employed Parallel Bill Testing. Best practice typically excludes this type of testing, because it does not include Business Process Procedure documentation, which details the business steps to execute a required transaction, identifying all required and optional fields. The preferable approach (User Acceptance Training) includes this documentation. Management's decision to use Parallel Bill Testing instead, eliminated thorough testing of non-bill processes. The schedule called for completion of Parallel Bill Testing on September 18, 2017. The last status report available indicated that the testing extended beyond October. We observed that management eliminated two tests. Thus, CMP both used an approach

that did not test all functionality and it then ran out of time to do further testing of the kind it selected.

The presentation of the bill comprises a primary touch point with customers. Incorrect bill presentment is a factor in inducing customer concern about the bill's accuracy in identifying charges and payments. One bill presentment issue remained outstanding at go-live. Management categorized it as low priority. That list expanded after go-live, producing a total of 11 documented bill presentment defects as of September 2018. Management did not know the numbers of customers affected by them. There had been only a small amount of testing in this area. For these 11 defects, only 12 customer accounts were tested as part of CMP's bill test scenarios.

2. Staffing Organization and Resources

Managing staffing effectively on projects like this one requires the right people, with the right skills and tools, performing the right tasks, at the right time. Effective staff management is essential to a successful outcomes. CMP experienced a number of resourcing challenges over the course of this project. Lack of sufficient resources substantially affected its ability to deliver the expected system functionality and quality, and to deal effectively with the operational and technical challenges experienced post go-live.

Project reports evidence resourcing challenges from January through go-live. CMP project team members had parallel non-project work assignments, a factor observed by project reports, for example:

- "Stretching resources very thin for project tasks in parallel with production support/other activities."
- "Stretching resources very thin for meeting project tasks and key deliverables" and "Spreading project resources too thin – overlapping efforts impacting quality of execution."
- Reporting of other Avangrid Projects, NY Regulatory Projects, REV/Energy Smart Community, REV/Community Net Metering, AMI and security activities to the Steering Committee as a source of resource competition.

Best practice moves from an overall functional and technical team structure to teams aligned for testing, training, conversion, and interfaces, for example. We did not find a designated test team with a test lead. We observed multiple assignments for the functional team members, creating dual roles for testing and training activities overlapping in time. The Avangrid approach to staffing produced teams with overall functional responsibility instead of focused roles, for example, just testing or training.

The SmartCare project involved many personnel, performing in a mix of internal and external resources working from six geographic areas (Augusta, New York, Connecticut, Spain, India & Portugal). The number of groups and locations and their geographical dispersion exceeds the norm for this type of project, and complicated efforts to integrate and advance work. A quality assurance report from the project integrator in February 2017 stated that:

> *Travelling resources continue to rotate in a 3 onsite, 1 offsite weekly rotation. This is due to budget alignment. A large portion of the client team, development team and consulting*

team works at other locations (other client offices in other cities, states and countries, or USI development centers). As the delivery continues to be delayed from the software factory, project management should consider greater co-location of the team, to allow for maximum efficiency.

In response to this concern, CMP did take steps to increase co-location of a portion of team resources. The core team members, including IT, business, integrator, and the Software Factory were co-located in Augusta, ME.

The next chapter addresses the impacts on customer service staffing from CMP's Voluntary Employee Separation Program (VESP) offering. Ten IT employees working in SAP CCS/CRM, SAP Work Management, Maine CS Legacy Billing Systems accepted CMP's offering, with November 1, 2017 departure dates coinciding with the start of -go live for the new system. CMP contracted with an unspecified number of these ten IT employees to remain after November 1, 2017.

3. Management of Third-Party Resources

The SmartCare project involved 32 vendors. Late vendor performance in developing and testing their interfaces caused SmartCare project delays, which in turn led to curtailment of planned testing, as discussed earlier. As early as September 2016, a project Quality Assurance evaluation of "Vendor Leadership" drew a "yellow" flag because several critical interfaces involving third-party work did not have fully-defined contracts or work scopes. Status reports for 2017 indicated continuous vendor issues.

Third-party vendors caused numerous delays and gaps in testing. Interface with the Meter Data Management (MDM) system proved especially challenging. Management scheduled a significant upgrade of this third-party provided system for go-live when planned for June 2017. The last project schedule shows a schedule delay to September 8, with actual go-live following that by about another three weeks on September 28. The delay made the interface unavailable for certain testing activities completed on September 24.

4. Quality Assurance

Making the transition to a new system as transparent as possible to customers comprises an important project goal. Success requires planning, management to the plan, and adherence to established criteria. Complex CIS projects never proceed without a hitch. Effective management must react to inevitable challenges by seeking an optimal balance among competing factors:

- Scope
- Quality
- Effort and availability of resources needed to provide it
- Cost
- Risk
- Adherence to project deadlines.

Project management and leadership used scope, schedule, and budget as key metrics on Executive Scorecards and Steering Committee Meeting reports. Management told us that these comprise the standard range of metrics for all Avangrid projects. Measures of quality (*e.g.*, ensuring the

system's production of timely and accurate bills through conforming application of processes, avoiding negative impacts on customers and CMP revenues) did not appear as reportable metrics. Some who do not give direct and focused attention to quality metrics claim them to be givens, which we view as an unsound perspective productive of an ineffective focus on quality. Good practice requires more than an assumption that expected quality exists - - it requires regular, objective measurement, response, and accountability. Adequate testing, results documentation, and defect capture and remediation comprise major measures for ensuring quality in projects like this one. One manager on the project reported "eyeballing" reports as a test of quality. Others said that the project produced the testing for which it had time to conduct and budget to accommodate.

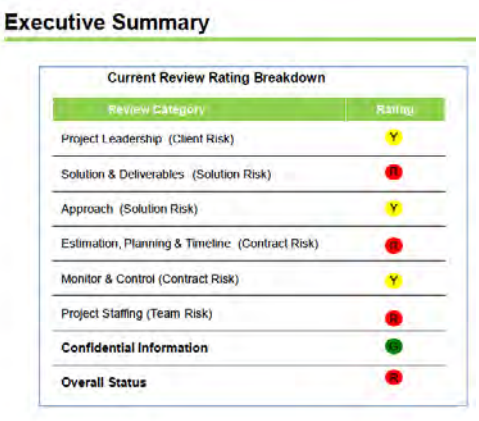
Status and quality reporting informs key project stakeholders of critical aspects of project health, defined by CMP as schedule, scope and cost. Effective reports provide a comprehensive, objectively measured basis for confirming status in accord with plans, or for laying a foundation for timely action to address correction and change. Sound reporting prevents surprises, by reporting status fully and timely and by identifying variances, trends, and emergent circumstances that may call for action. Formal status reporting needs to precede and be available for project steering committee meetings as well. Its use for project management is even more critical and time sensitive. The information provided should be clear, concise, and actionable.

We did not find clear, concise, and actionable project reporting. CMP provided three status reports:

- Steering Committee reports and MS Project produced by the Project Management Office
- Avangrid Customer SmartCare Project Summary by Project Manager and the technical and functional leads
- Quarterly Project Quality Assurance Reports by the third-party project integrator.

Status and quality reporting should provide critical information for executives responsible for milestone decisions. The decision to go-live (to be fully operational) faced the project Steering Committee and Executive Sponsors with a particularly critical situation - - one with significant implications for performance quality and customer satisfaction. This decision must consider readiness of the solution and of the organizations responsible for providing, supporting, and using the solution. This decision should be informed by several sources and types of data.

CMP's multiple reports produced conflicting information. We compared status reporting coinciding with the project integrator's quality assurance review (Implementation Engagement Review Memo, for February 22, 2017). The integrator's summary rated project performance areas. It assigned a green indicator to one area, yellow to three, and red rating to four. The summary assigned a red indicator to overall status.

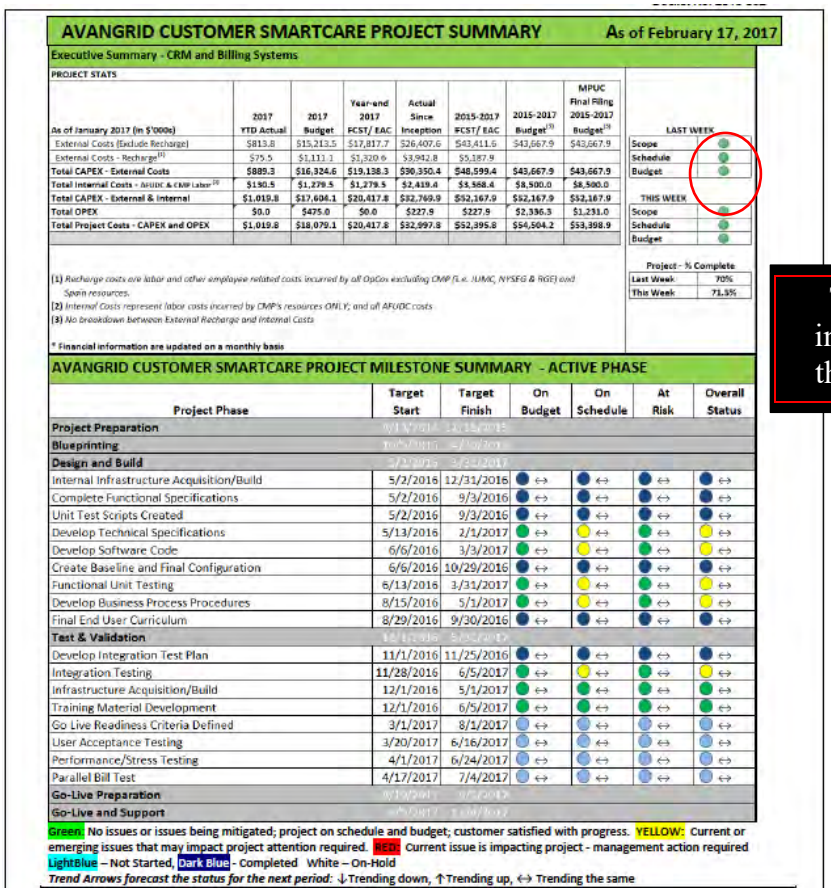

Executive Summary

Current Review Rating Breakdown

Review Category	Rating
Project Leadership (Client Risk)	Y
Solution & Deliverables (Solution Risk)	R
Approach (Solution Risk)	Y
Estimation, Planning & Timeline (Contract Risk)	R
Monitor & Control (Contract Risk)	Y
Project Staffing (Team Risk)	R
Confidential Information	G
Overall Status	R

By contrast, Avangrid's own Customer SmartCare Project Summary of February 17, 2017 provides a fundamentally different view of status in the same period. The key indicators show green, with a few activities rated as yellow. The conflict with the integrator's assessment is notable. Management reported

to us that CMP was in agreement with the integrator's quality assurance reviews and that the integrator did not tell them anything they did not already know. The status report conflicts suggest otherwise.



AVANGRID CUSTOMER SMARTCARE PROJECT SUMMARY — As of February 17, 2017

Executive Summary - CRM and Billing Systems

PROJECT STATS

As of January 2017 (in $'000s)	2017 YTD Actual	2017 Budget	Year-end 2017 FCST/ EAC	Actual Since Inception	2015-2017 FCST/ EAC	2015-2017 Budget[3]	MPUC Final Filing 2015-2017 Budget[3]
External Costs (Exclude Recharge)	$813.8	$15,213.5	$17,817.7	$26,407.6	$43,411.6	$43,667.9	$43,667.9
External Costs - Recharge[1]	$75.5	$1,111.1	$1,320.6	$3,942.8	$5,187.9		
Total CAPEX - External Costs	**$889.3**	**$16,324.6**	**$19,138.3**	**$30,350.4**	**$48,599.4**	**$43,667.9**	**$43,667.9**
Total Internal Costs - AFUDC & CMP Labor[2]	$130.5	$1,279.5	$1,279.5	$2,419.4	$5,568.4	$8,500.0	$8,500.0
Total CAPEX - External & Internal	**$1,019.8**	**$17,604.1**	**$20,417.8**	**$32,769.9**	**$52,167.9**	**$52,167.9**	**$52,167.9**
Total OPEX	**$0.0**	**$475.0**	**$0.0**	**$227.9**	**$227.9**	**$2,336.3**	**$1,231.0**
Total Project Costs - CAPEX and OPEX	**$1,019.8**	**$18,079.1**	**$20,417.8**	**$32,997.8**	**$52,395.8**	**$54,504.2**	**$53,398.9**

LAST WEEK: Scope, Schedule, Budget

THIS WEEK: Scope, Schedule, Budget

Project - % Complete: Last Week 70%; This Week 71.5%

(1) *Recharge costs are labor and other employee related costs incurred by all OpCos excluding CMP (i.e. JUMC, NYSEG & RGE) and Spain resources.*
(2) *Internal Costs represent labor costs incurred by CMP's resources ONLY; and all AFUDC costs*
(3) *No breakdown between External Recharge and Internal Costs*

* Financial information are updated on a monthly basis

AVANGRID CUSTOMER SMARTCARE PROJECT MILESTONE SUMMARY - ACTIVE PHASE

Project Phase	Target Start	Target Finish	On Budget	On Schedule	At Risk	Overall Status
Project Preparation						
Blueprinting						
Design and Build						
Internal Infrastructure Acquisition/Build	5/2/2016	12/31/2016	↔	↔	↔	↔
Complete Functional Specifications	5/2/2016	9/3/2016	↔	↔	↔	↔
Unit Test Scripts Created	5/2/2016	9/3/2016	↔	↔	↔	↔
Develop Technical Specifications	5/13/2016	2/1/2017	↔	↔	↔	↔
Develop Software Code	6/6/2016	3/3/2017	↔	↔	↔	↔
Create Baseline and Final Configuration	6/6/2016	10/29/2016	↔	↔	↔	↔
Functional Unit Testing	6/13/2016	3/31/2017	↔	↔	↔	↔
Develop Business Process Procedures	8/15/2016	5/1/2017	↔	↔	↔	↔
Final End User Curriculum	8/29/2016	9/30/2016	↔	↔	↔	↔
Test & Validation						
Develop Integration Test Plan	11/1/2016	11/25/2016	↔	↔	↔	↔
Integration Testing	11/28/2016	6/5/2017	↔	↔	↔	↔
Infrastructure Acquisition/Build	12/1/2016	5/1/2017	↔	↔	↔	↔
Training Material Development	12/1/2016	6/5/2017	↔	↔	↔	↔
Go Live Readiness Criteria Defined	3/1/2017	8/1/2017	↔	↔	↔	↔
User Acceptance Testing	3/20/2017	6/16/2017	↔	↔	↔	↔
Performance/Stress Testing	4/1/2017	6/24/2017	↔	↔	↔	↔
Parallel Bill Test	4/17/2017	7/4/2017	↔	↔	↔	↔
Go-Live Preparation						
Go-Live and Support						

Green: No issues or issues being mitigated; project on schedule and budget; customer satisfied with progress. YELLOW: Current or emerging issues that may impact project attention required. RED: Current issue is impacting project - management action required
LightBlue – Not Started, Dark Blue - Completed White – On-Hold
Trend Arrows forecast the status for the next period: ↓Trending down, ↑Trending up, ↔ Trending the same

The integrator indicated red for these categories.

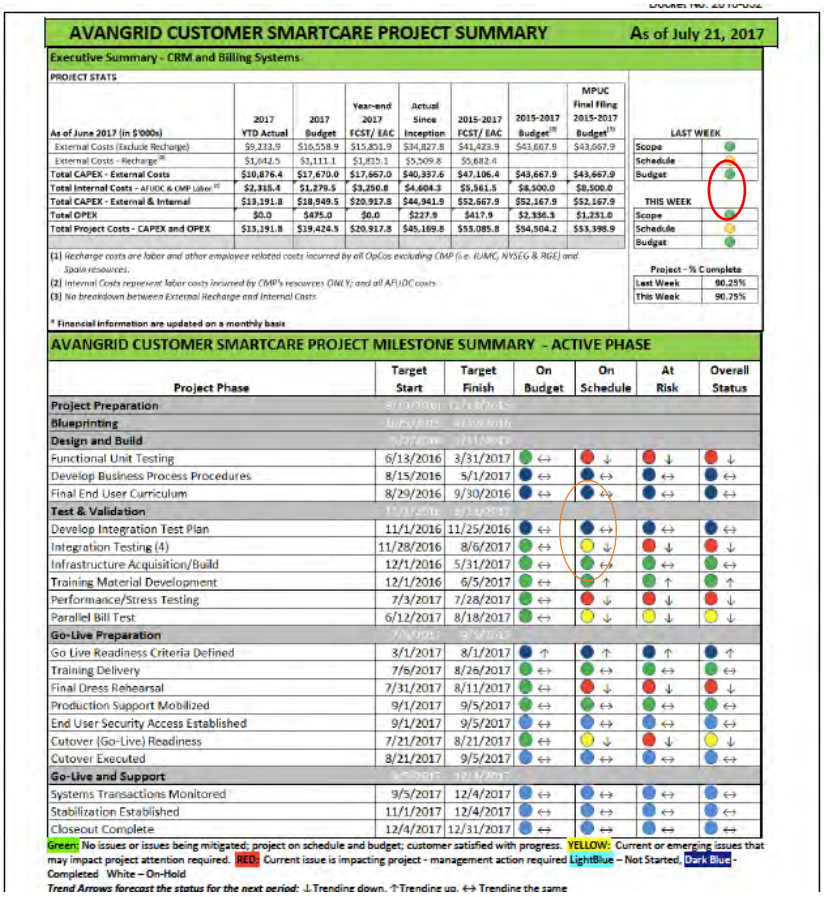
The second and last 2017 project integrator review on July 17, 2017 indicated status as red.

Executive Summary

Current Review Rating Breakdown

Review Category	Rating
Project Leadership (Client Risk)	
Solution & Deliverables (Solution Risk)	
Approach (Solution Risk)	
Estimation, Planning & Timeline (Contract Risk)	
Monitor & Control (Contract Risk)	
Project Staffing (Team Risk)	
Confidential Information	
Overall Status	

By contrast, the Avangrid Customer SmartCare Project Summary of July 21, 2017, remained green and yellow on overall criteria, with some evaluation criteria turning yellow or red. About 80 percent of the content of these reports came in the form of narrative, that did not provide a foundation for the continued green ratings.



AVANGRID CUSTOMER SMARTCARE PROJECT SUMMARY — As of July 21, 2017

Executive Summary - CRM and Billing Systems

PROJECT STATS

As of June 2017 (in $'000s)	2017 YTD Actual	2017 Budget	Year-end 2017 FCST/ EAC	Actual Since Inception	2015-2017 FCST/ EAC	2015-2017 Budget[2]	MPUC Final Filing 2015-2017 Budget[3]
External Costs (Exclude Recharge)	$9,233.9	$16,558.9	$15,851.9	$34,827.8	$41,423.9	$43,667.9	$43,667.9
External Costs - Recharge[1]	$1,642.5	$1,111.1	$1,815.1	$5,509.8	$5,682.4		
Total CAPEX - External Costs	**$10,876.4**	**$17,670.0**	**$17,667.0**	**$40,337.6**	**$47,106.4**	**$43,667.9**	**$43,667.9**
Total Internal Costs - AFUDC & CMP Labor[2]	**$2,315.4**	**$1,279.5**	**$3,250.8**	**$4,604.3**	**$5,561.5**	**$8,500.0**	**$8,500.0**
Total CAPEX - External & Internal	**$13,191.8**	**$18,949.5**	**$20,917.8**	**$44,941.9**	**$52,667.9**	**$52,167.9**	**$52,167.9**
Total OPEX	**$0.0**	**$475.0**	**$0.0**	**$227.9**	**$417.9**	**$2,336.3**	**$1,231.0**
Total Project Costs - CAPEX and OPEX	**$13,191.8**	**$19,424.5**	**$20,917.8**	**$45,169.8**	**$53,085.8**	**$54,504.2**	**$53,398.9**

LAST WEEK: Scope, Schedule, Budget

THIS WEEK: Scope, Schedule, Budget

Project - % Complete

Last Week	90.25%
This Week	90.75%

(1) *Recharge costs are labor and other employee related costs incurred by all OpCos excluding CMP (i.e. IUMC, NYSEG & RGE) and Spain resources.*
(2) *Internal Costs represent labor costs incurred by CMP's resources ONLY; and all AFUDC costs*
(3) *No breakdown between External Recharge and Internal Costs*

* Financial information are updated on a monthly basis

AVANGRID CUSTOMER SMARTCARE PROJECT MILESTONE SUMMARY - ACTIVE PHASE

Project Phase	Target Start	Target Finish	On Budget	On Schedule	At Risk	Overall Status
Project Preparation						
Blueprinting						
Design and Build						
Functional Unit Testing	6/13/2016	3/31/2017	↔	↓	↓	↓
Develop Business Process Procedures	8/15/2016	5/1/2017	↔	↔	↔	↔
Final End User Curriculum	8/29/2016	9/30/2016	↔	↔	↔	↔
Test & Validation						
Develop Integration Test Plan	11/1/2016	11/25/2016	↔	↔	↔	↔
Integration Testing (4)	11/28/2016	8/6/2017	↔	↓	↓	↓
Infrastructure Acquisition/Build	12/1/2016	5/31/2017	↔	↔	↔	↔
Training Material Development	12/1/2016	6/5/2017	↔	↑	↑	↑
Performance/Stress Testing	7/3/2017	7/28/2017	↔	↓	↓	↓
Parallel Bill Test	6/12/2017	8/18/2017	↔	↓	↓	↓
Go-Live Preparation						
Go Live Readiness Criteria Defined	3/1/2017	8/1/2017	↑	↑	↑	↑
Training Delivery	7/6/2017	8/26/2017	↔	↔	↔	↔
Final Dress Rehearsal	7/31/2017	8/11/2017	↔	↓	↓	↓
Production Support Mobilized	9/1/2017	9/5/2017	↔	↔	↔	↔
End User Security Access Established	9/1/2017	9/5/2017	↔	↔	↔	↔
Cutover (Go-Live) Readiness	7/21/2017	8/21/2017	↔	↓	↓	↓
Cutover Executed	8/21/2017	9/5/2017	↔	↔	↔	↔
Go-Live and Support						
Systems Transactions Monitored	9/5/2017	12/4/2017	↔	↔	↔	↔
Stabilization Established	11/1/2017	12/4/2017	↔	↔	↔	↔
Closeout Complete	12/4/2017	12/31/2017	↔	↔	↔	↔

Green: No issues or issues being mitigated; project on schedule and budget; customer satisfied with progress. YELLOW: Current or emerging issues that may impact project attention required. RED: Current issue is impacting project - management action required LightBlue – Not Started, Dark Blue - Completed White – On-Hold

Trend Arrows forecast the status for the next period: ↓Trending down. ↑Trending up. ↔ Trending the same

Marked dark blue as complete, instead of green for no issues, satisfied with the progress.

The Steering Committee report for the same period indicated the following challenges:

- Overlapping of critical activities for the remainder of the project.
- Resource constraints – individuals maximized in addition to other competing initiatives/priorities.
- Final preparation timeline has required the prioritization of critical activities that are the minimum required to get the project to Go-Live in September. For example, the removal of some initially planned activities, like User Acceptance Testing, Dress Rehearsal #3, and compression of Billing Parallels (Execution and remediation).
- Business Readiness
    - Business familiarity with the solution limited to the project team (NY and UIL Resources)
    - Post Go-Live organizational support strategy in development.

These reports prepared by CMP with the same status indicators, along with the Go-Live Readiness Checklist and Executive Dashboard, detailed project status and provided support documentation for the go-live decision.

5. Managing Project Schedule

A project like the SmartCare project should operate under a detailed project plan updated weekly. Good practice calls for the creation of a master, detailed schedule at initiation, supported by an

appropriate schedule tool (for example, MS Project). Gantt or PERT charts should be continually updated to support effective tracking, monitoring, and reporting of progress.

Status reports to the Steering Committee in 2017 did not contain Gantt or Pert charts directly from the project plan. Status reports showed the timeline at a very high level and in Excel format. Identification and assessment of critical path activities is important in analyzing downstream impacts of current sources of delay and in making adjustments to address slippage. The lack of critical path analysis obscures understanding of true schedule status, what is driving delays and resource overload, and where action can be taken to recover. The SmartCare project's 2017 status reports provided did not report critical path information. We did not see indications of use of critical path analysis to analyze impacts or options for addressing schedule slippage. The Project Management office and Project Lead team reportedly used MS Project to access daily and weekly to monitor task progression, dependencies, pre-requisites and milestone items, but the MS Project reports provided were outdated, incomplete and contained inaccurate information, such as User Acceptance Testing information (detailed below).

CMP's Project Manager adopted a different tool (HP ALM). The Integrator's Project Management Office created and maintained the CIS plan using MS Project. This plan was seemingly loosely maintained by the Office. The final MS Project plan shows activities eliminated (User Acceptance Testing, for example) instead as 100 percent completed, including a completion date. Dates presented in MS Excel format do not match the MS Project plan. This was a large project, involving some 250 resources. Reliance on high-level reporting in Excel format sacrificed key information and analysis needed to identify gaps in resources and impact to critical path.

6. Management of Risk and Issues

Billing and other CIS transitional risks and issues require sound and comprehensive definition, accompanied by commensurate mitigation activities. Per the SmartCare Project Office Plan:

> *Tracking of important risks/issues will help to improve awareness, escalate importance and assure timely and quality resolution. We will utilize the PMC tool to document and status all Risks/Issues. Communication of the risk/issue resolution will be critical to making sure all impacted parties are aware of any decisions or changes made as each risk/issue is worked.*

The CMP Project Manager began the project using a risk tool from the third-party project integrator, switching to managing risks and issues within HP ALM and in status reports. Initially, the PMC tool tracked and managed risks and project level issues, with a last recorded issue dated April 2017. Risks were not dated. We did not see tracking of the number opened and closed per month. Trending of opened/closed risks was not possible. Considering the whole range of project reporting it was impossible to gain a clear picture of risk, and no tracking indicated level of severity or mitigation actions.

7. Project Readiness

CMP developed plans to address the readiness of the organization for go-live and post go-live. However, compressed timelines leading up to go-live, exception and defect volumes, insufficient

reporting, and monitoring of Key Performance Indicators (KPIs) post go-live, adversely affected the execution of those plans.

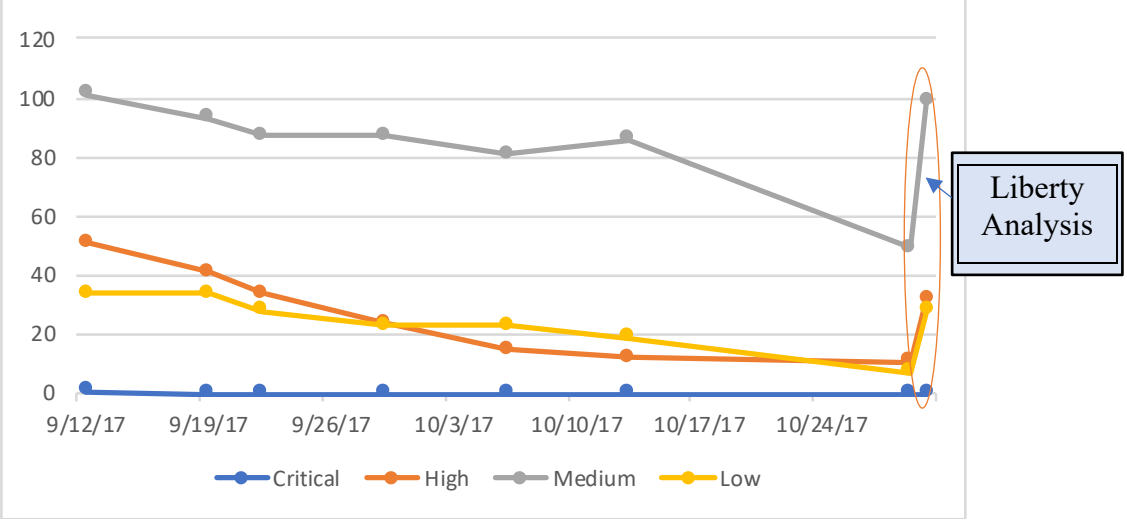
The project readiness (go-live acceptance) criteria were defined, tracked and reported. Per the SAP Networks Go-Live readiness Sign-Off the decision required a discussion and sign off by project team and Steering Committee members. Incomplete minutes and tracking make unclear who signed off and whether information about defects was correct. The readiness signoff had no signatures and CMP reported that approval came verbally. The last status report with substantial detail, October 13, 2017, indicated much work remaining to be done. Only summary status reports came after this date, with all project resources assigned to post go-live support teams.

A defect refers to an error, change request, or enhancement requiring IT assistance to resolve. The final sign off indicated defect go-live goals as follows:

- No Critical open defects
- No High open defects
- Number of open Medium Defects with agreed workarounds.

No critical or high defects were reported for this sign off. This data is inconsistent with other reporting provided by CMP. We were provided with inconsistent information about defects by management. Management advised that the inconsistency resulted from project staff's opening and closing of defects continuously. The next chart summarizes defect information from CMP status reports through October 29 (with our numbers as the last data points on the graph).

Reported Defects at the Go-Live Decision



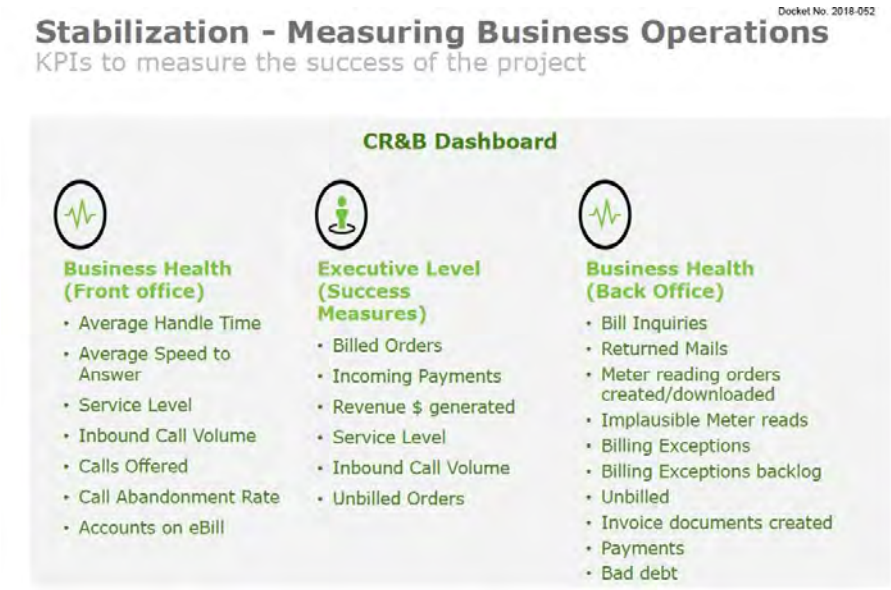
Our count using data provided by CMP produced different defect numbers at go-live. It is impracticable to determine precisely the volume of defects at go-live.

8. Post Go-Live Plan and Management

Project performance metrics, termed Key Performance Indicators (KPIs), are key to ensuring a transition that minimizes billing problems, delays in handling customer inquiries, and customer complaints. Effective use of KPIs includes setting targets (the desired level of performance) and

tracking progress against that target. CMP did not set targets supporting measurement of success based on meeting KPIs. Post go-live metrics should have been well defined, tracked, and reported. CMP did not develop metrics to track and measure defect closure time, average days to resolve a customer inquiry or other customer facing metrics.

The following chart is from the CMP SmartCare Project Overview June 2018. Management reported establishing the following KPIs to manage the success of the project. The information provided sets no objective targets, only areas of performance considered key.



CMP reported to the Steering Committee "All metrics (business and system) continue to track to expectations." However, the lack of established targets for these performance indicators as of October 11, 2018, did not give a basis for translating those expectations to specific targeted levels of performance.

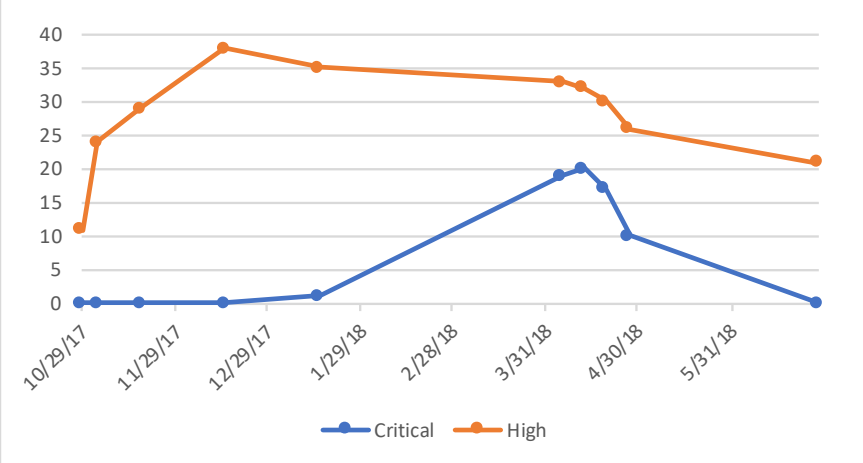
Management faced a significant number of issues to resolve while already using the system live to bill and support customers. A long list of issues not resolved prior to go-live existed, and still needed resolution. CMP dedicated its post-go-live plan primarily to addressing questions identified during the initial 90-days after go-live including a level 3 support dedicated to detailed analysis of questions, issues and prioritization. After the initial 90-days post go-live, a plan was provided to address the staffing needed to analyze, prioritize, correct, manual bill, or test both the new and old defects, while managing daily jobs at the same time.

CIS implementations typically involve the discovery of unanticipated problems, sometimes numerous and significant, post go-live. Utility industry response to these problems varies from continuous work across a period of months or years to correct errors and processes to launching a problem resolution phase within six months of go-live. CMP planned a post-go-live support effort for three months, subject to revisit. Support organizations became burdened with addressing many system issues, leaving inadequate time available to resolve defects and billing exceptions.

Consequences included compounding billing problems and the failure to release bills for multiple billing cycles.

Management did not grasp the full gravity of the issues post go-live; they were not properly communicated to the Steering Committee. As defects continued to be reported, the January 15 Steering Committee report said, "All Critical/Highs targeted for completion by Friday January 26. Identified Medium and Low severity defects will continue to be resolved." From status reports post-go-live, we compiled the number of critical and high defects shown in the following chart. They increased significantly since that January 2018 report. Inconsistent reporting did not provide the data to determine the trend. Sometimes all defects were reported, sometimes only critical and high defects were reported. Below are the critical and high defects reported sporadically in post go-live status reports.

Critical and High Post-Go-Live Defects



After January 2018, CMP made problem resolution part of the everyday workload. We observed no clear leader made accountable or any documented plan to address the backlog of defects. The functional business leader took the early-departure offer described above. A manager from New York then transitioned to managing what CMP termed "Phase 2." A manager in Connecticut now fills this role, but we did not find clarity among employees on how this phase operates. IT staff resources have disbanded, some leaving under the early out, and others now in other jobs within the organization. CMP addresses defects provided through HP ALM and report generally that defects are slow to close because of the testing needed by the functional owners.

C. Conclusions

Lack of testing and the right type of testing caused post go-live defects that affected customer satisfaction and revenue. Management minimized or failed to recognize the severity of defects raised before launching the CIS. Conflicting information in status reports, readiness reports and the master list of defects demonstrates a lack of recognition of the magnitude of the issues existing. CMP reported some of the defects as closed but not documented until after go-live, reflecting an ongoing problem with the reporting for this project.

Multiple cycles of Parallel Bill Testing did not yield the results needed to evaluate the readiness

of all functionality. Eliminating planned User Acceptance Testing cost management a more suitable assessment of system readiness. The lack of testing caused incorrect bills and lost revenue. A degraded customer experience resulted, as large numbers contacting CMP about their bills overwhelmed resources and left them without the ability to give customers clear, accurate information.

Management's focus on schedule and budget without sufficiently prioritizing quality adversely affected CIS implementation and contributed to defects, billing issues, and customer concern and mistrust. Management achieves quality through testing. Testing here was compressed and incomplete. The lack of experienced full-time dedicated staff combined with a functional team organized to cover both testing and training contributed to testing behind schedule and truncated.

Lack of a strong project plan, combined with the variable quality of status reporting, complicated efforts to identify and resolve problems prior to go-live. The detailed project plan created by the Project Management Offices was not used to manage the project and the use of HP ALM did not allow project management to view overallocation of resources accurately or understand fully the impacts of activity slippage on overall project schedule. Management decided to go-live on the basis of information at a summary level as reporting to the Steering Committee lacked sufficient detail to determine work still required before go-live.

Lack of post go-live planning and management for defect resolution and staff to manage these defects created a large backlog, which still remains. SmartCare went live with known defects requiring later resolution. Defects discovered internally after go-live and in response to customer inquiries and complaints added substantially to an already substantial list. The retirement offering cost management critical knowledge. The failure to establish a team not encumbered by other substantial day-to-day work has also impaired the ability and time to correct defects material to billing and customer satisfaction.

VIII. Customer Inquiries and Complaints

A. Background

Managing the interchange with customers effectively promotes understanding of service rates, terms, and conditions. Utilities who fail to handle this relationship properly face increased numbers of customers who consider the relationship between them and a trusted supplier breached. Management therefore needs to place particular emphasis on providing responsive customer service through the whole chain of contact, from initially setting up to finally closing an account. This cycle includes answering calls during normal working hours and assuring well-trained customer service representatives. These representatives require support from advanced systems that allow quick retrieval of accurate information, and they depend on policies and procedures delineating methods and techniques for solving customer problems readily. Management must make sufficient numbers of experienced supervisory personnel available to manage call centers, with sufficient numbers prepared to deal with more difficult customer problems.

We examined the timeliness and quality of CMP's communications with customers, addressing:

- Time required to respond to customer calls
- Responses to high-bill inquiries and complaints
- Reasonableness of responses to customer calls.

Concerns about these aspects of the "customer experience" have grown since last fall. High inquiry and complaint levels stress the resources available to respond timely and effectively to customer concerns. How well utilities handle calls and complaints forms a central element of the metrics used by virtually all utilities when measuring how well they are serving customers. Large numbers of customer complaints followed CMP's introduction of SmartCare (coincident with a major storm and followed by cold weather) and customer-service performance metrics remained degraded through June of 2018.

Specific areas of performance we examined included:

- Call center and billing performance before and during last winter
- Customer service systems, representatives, and work activities
- Recent practices for responding to customer contacts and complaints
- Pre- and post-go-live call center staffing levels for sufficiency
- Call center storm response plan, roles, responsibilities, outcomes, and lessons learned
- Customer and employee communications plans and messaging to inform customers of changes under the new billing system introduced
- Trends in inquiry/complaint resolution timeliness and effectiveness.

The system issues that affect billing accuracy can also impair other customer service functions, all the more so during the transition to a new customer information system. If customers cannot get clear, convincing answers or rely on timely solutions to inquiries, complaints, and billing errors, increasing loss of confidence in their electric utility and concern begins to turn to skepticism. Doubt in the validity of even those answers that are correct and responses that are effective under the circumstances increases. We examined systems having the potential for affecting call answering and inquiry and timely and effective complaint resolution.

Cutover to a new customer information system typically results temporarily in longer call handling times as personnel navigate a new system and often must explain to customers why bills look different. Longer wait times and increased volumes of calls can result. Management can mitigate transitory impacts by scheduling additional representatives on the floor, increasing on-hand support, and defining clear paths to escalate issues and complaints. We examined how management planned for and managed the transition to SmartCare in the call center, paying attention to risk identification, staffing plans, training, intraday management, escalation processes, quality assurance, and complaint handling. The new customer information system cutover came the same weekend as a severe windstorm with 400,000 customer outages. We also examined Call Center storm response plans, roles, responsibilities, and outcomes.

Customer-service performance metrics provide one key indicator of concerns and issues arising from system changes. A significant degradation in CMP's call center performance coincided with the October 2017 deployment of SmartCare. For example, the number of calls and callers abandoning climbed significantly. Abandonment rates tripled from September 2017's 11 percent to February 2018's 35 percent. Call volumes for the first two months of 2018 ran 70 percent higher than the corresponding months of 2017. More customers were calling, but failing to get through to discuss inquiries, concerns, and complaints. We examined specific and quantified goals and objectives and (most importantly) performance against them and the sources of any lingering gaps, in order to identify any system issues that may underlie them.

B. Findings

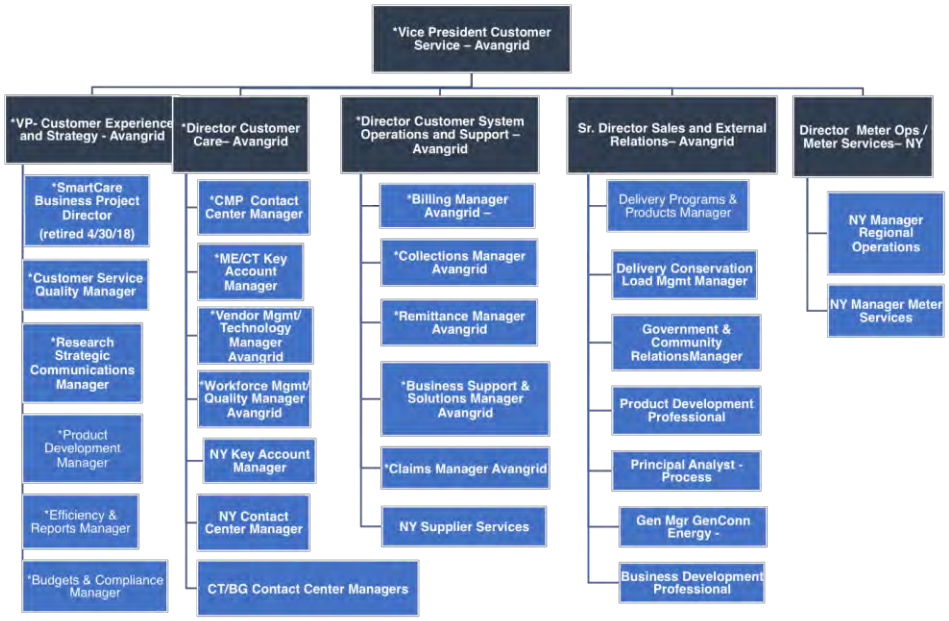
1. CMP's Customer Service Organization

CMP provides customer service through phone, field, and web services across an 11,000 square mile service area in central and southern Maine. Residential customers comprise 90 percent of the total, and 40 percent of total kilowatt-hour sales. CMP's customers account annually for more than a million customer calls and 7.3 million bills issued.

CMP reorganized customer service functions in December 2017, after appointment of the Avangrid Vice President of Customer Service, moving from a decentralized, company-functional organization to the structure in place today. The new organization moved responsibility for customer service functions from the CMP Vice President of Customer Service to Avangrid. At the same time, responsibilities for Meter Operations and Meter Services moved from the CMP Customer Service organization to Operations Technologies and Regional Operations.

The following chart shows the customer service organization operating under Avangrid's Vice President (VP) of Customer Service. This organization carries out most customer-facing functions. Responsibilities include customer service operations from all Avangrid operating companies, and includes the customer contact centers, billing, collections, remittance, supplier services (in New York), key accounts, customer experience, and sales and external relations (in states other than Maine).

CMP Customer Service Organization



* Has responsibility for CMP function

Avangrid's Director of Customer Care oversees contact centers, key accounts, vendor management, and customer service technologies. CMP's Contact Center Manager reports to the Director of Customer Care. Avangrid's Director of Customer System Operations and Support oversees billing, payment and collections. CMP's Billing Supervisor reports to Avangrid's Billing Manager, who oversees billing operations within all Avangrid operating companies.

2. Call Center and Billing Staffing

The next table summarizes year-end staffing in the customer service functions of the Contact Center and Billing groups, each of which supplements in-house staffing with third-party resources. Their staffing levels in Billing and the Call Center have increased since 2016. The numbers for 2018 are through August; management reports staffing additions since then.

Customer Contact Center and Billing Staffing

Function	2016	2017	2018	Function	2016	2017	2018
Contact Center	145	167	183	Billing	8	9	10
Representative	63	83	85	Analyst	4	5	3
Specialist	5	4	4	Lead Analyst	3	3	2
Other Staff	3	3	2	-	-	-	-
Supervisor	4	4	5	Supervisor	1	1	1
Manager	2	2	0	-	-	-	-
In-House Total	77	96	96	In-House Total	8	9	10
External	68	71	87	External	0	0	4

The consolidation of the Portland and Augusta contact centers in 2015 was accompanied by a voluntary separation package offering to affected employees. AVANGRID announced later, in September 2017 four voluntary separation offers for certain non-union, Customer Service organization employees. This offer applied to those working on AVANGRID's SmartCare, Click (field service order), and New York Meter Services projects. Depending upon the plan selected, employees agreeing to the offer could work through either November 30, 2017 or April 30, 2018. These voluntary separation offers came as part of a large-scale AVANGRID reorganization.

Customer Service employees became aware of the offers the weekend before SmartCare's end-of-October go-live date. Thirteen customer service employees accepted the offer, and left in April 2018:

- 1 Director Customer Service
- 4 Managers (Customer Relations Center, Customer Service Quality, Marketing & Sales, and Revenue Recovery)
- 1 Customer Relations Center Supervisor
- 2 Customer Billing Analysts
- 1 Customer Relations Center Analyst
- 3 Lead Analysts (Contract Administration, Customer Service, Key Account Management)
- 1 Analyst Key Account Management.

These departures came at a time when call volumes, customer complaints, and billing exceptions were at very high levels. Six of the departed employees had comprised part of the Customer Service and Call Center management team.

Management did ramp up call center staffing ahead of the new system with temporary employees. However, the Billing group did not supplement its resources until the billing backlogs exceeded in-house staff capacity and many customer bills were delayed. In February 2018, CMP enlisted an RGE billing analyst on the project to work full time as an offsite resource. Around April 2018, CMP used two UI billing analysts both on site and off site to assist in billing backlogs. The UI team continues to assist.

CMP management underestimated the level of billing work following SmartCare deployment and it failed to staff the Billing group adequately to meet the increasing volume of billing exceptions and manual work in the months following SmartCare go-live. Management underestimated the period of time to stabilize SmartCare and the impact that deployment would have on the billing group. The group was accustomed to 300 to 400 billing exceptions per day with the legacy CIS and management expected 1,000 per day under SmartCare. In the three months following go-live, CMP received double that rate, producing more than 120,000 exceptions. Many involved code defects, as explained in the preceding chapter, or configuration settings, both of which required additional time to resolve. Over the months following go-live, CMP and its systems integrator worked to address the growing number of system defects, billing errors, and billing exceptions.

CMP's billing group did not have enough resources to address high levels of exceptions generated by the system on a daily basis. Backlogs in billing work began to accumulate in February and March 2018. Management secured third-party resources to assist with exception processing, and

at the same time adjusted threshold settings in the system to focus resources on the most critical billing exceptions. This adjustment helped, but the system defects and billing errors created additional work for the billing group. For example, it required manual bills in some cases until code could be developed, to address underlying defects.

At the end of April 2018, with the backlog growing, the two analysts who accepted the early separation option left the company. Their departures left the billing group below normal staffing levels at a time of significantly increased workload. The third-party resources assigned to the backlogged work helped to free billing group personnel to focus on the more difficult work. Management filled both vacancies by July, and reports recently hiring three additional full-time people. Management also brought back two retirees immediately after the VESP effective dates. They currently remain on board to resolve billing exceptions.

3. Sufficiency of Supervisory Resources

CMP Call Center supervisory span of control (the average number of employees reporting to one supervisor) widened significantly at go-live and has remained high. During 2016, CMP averaged a supervisory span of control of 13 agents to one supervisor. This ratio climbed to a peak of 25:1 in July 2017 as CMP prepared for go-live of the SmartCare system. While CMP added CSRs to address expected increases in call volumes, it did not add supervisors to support the increase in agents.

Supervisors support their teams of agents, monitoring performance and quality, and provide coaching to improve skills and consistency. CMP did not replace a supervisor who left in September 2016. One of the two managers took responsibility for supervising the representatives assigned to the departed supervisor. Two more supervisors left the Call Center in March and April of 2018. CMP filled the three total supervisory vacancies in April and July 2018. The additions reduced the span of control to 18 CSRs per supervisor, still slightly high in the industry and above CMP's 2016 levels.

4. Customer Satisfaction Measurement

CMP measures customer satisfaction through a transactional contact satisfaction survey. A third-party vendor conducts telephone surveys of customers recently contacting CMP by phone or web. Survey questions explore overall satisfaction with CMP, with the agent handling the call, and with other items, such as the number of calls to resolve and ability to complete transactions through the website or automated telephone system. CMP reports the results of these surveys monthly, measuring them against a goal of at least 85 percent customer satisfaction. The next chart shows reported results from January 2016 through August 2018.

CMP's customer satisfaction, as measured daily and reported monthly through recent contact surveys, has declined since December 2017, falling below management's goal of 85 percent or higher satisfaction.

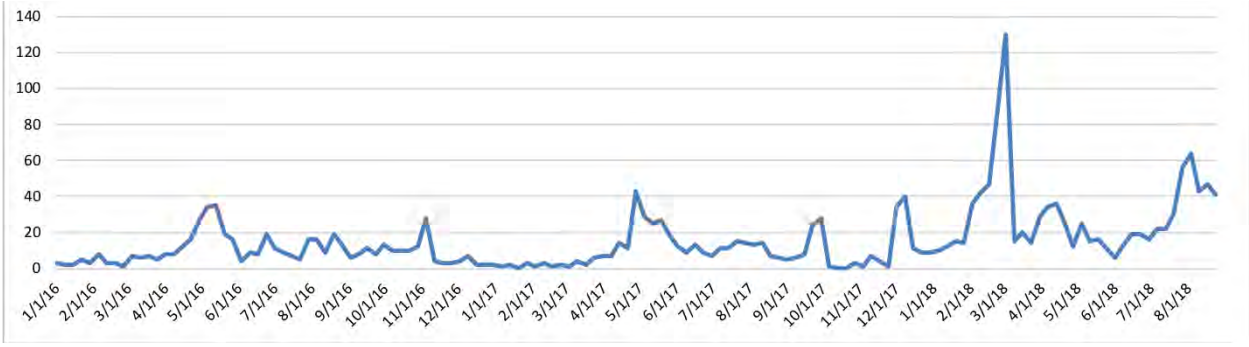
5. Customer Complaint Resolution

Customers with complaints about a bill, hardship-status determination, or payment arrangement can contact customer service representatives at the Call Center. Customers can also call the Commission's Consumer Assistance & Safety Division (CAD) if dissatisfied with payment arrangements offered, or to make a complaint after speaking with the company about any aspect of the utility's business for which the Commission has jurisdiction. The Division sends notification of a complaint's opening, and issues a case number. Within a few days, the Division sends, if needed, an information request to CMP to which the company has 10 days to respond. Upon review, Commission personnel issue a decision, after which the customer or the utility has 10 days to appeal.

The Commission modified the process in February 2018 following an extraordinarily large number of calls and corresponding complaints about CMP service and billing, particularly high bills. Larger than historical numbers of customers bypassed CMP, making first contact with the Commission. The modification involved Commission collection of contact information and daily referrals of customers with high bill concerns to CMP. As customers are referred to CMP, the CAD sends each customer a letter explaining that the customer's complaint was referred to CMP for resolution and that the customer would be hearing from CMP in the near future. At week end, CMP provides the CAD with a spreadsheet containing the names of customers referred by the CAD and detailing any actions taken by CMP to resolve each customer's complaint. CMP tracks these inquiries in a separate spreadsheet from its tracking of complaints through the normal dispute process. Two CMP employees regularly contact customers to seek problem resolution and answer questions.

Customer complaints filed against CMP with the Consumer Assistance & Safety Division have increased significantly following SmartCare deployment, and without timely CMP response. CMP typically receives about 400 complaints per year, with the majority arriving following the end of the winter collection moratorium period (April). The next chart shows the increase.

CAD Complaints Received



CMP received 2,352 referrals from the Division from February through June 14, 2018. The bulk of referrals were made during March and April 2018. The next table shows by month average days to resolve and days until contact.

Inquiry & Complaint Referrals Resolution Durations

Month	Inquiries Received	Days to Resolve	Days to Contact
Feb	58	6	6
Mar	1,317	17	16
Apr	630	34	34
May	262	22	21
Jun	85	7	7
Average	470	19	18

For the 425 customers whose issue was resolved, as of June 14th, CMP's resolution averaged 19 days with an average of 18 days to first contact. Response times in March, April, and May were significantly longer than average however, as the number of inquiries accumulated.

Overall, CMP's responsiveness to customer complaints during this period has been poor. Of the 2,383 customers referred by the Division, CMP was only successful in contacting 42 percent. The left table below shows that many more customers were not reached. Additionally, of those cases that could be resolved, only 30 percent were resolved within 10 days, the remainder took from 10 to more than 30 days to resolve, as seen in the table below on the right.

Inquiries Received		Days to Resolve	
Resolved	425	< 10 days	29%
Not-Resolved (complaint)	570	10 to 20 days	27%
Left Message	1,227	20 to 30 days	28%
Unable to Reach[1]	161		

CMP management recognizes that it has not responded to these Consumer Assistance & Safety Division referrals in a timely manner. This group has been staffed with two employees.

Management stated that it was seeking an additional employee to assist. CMP staffs this position with some of its best trained employees, who are skilled in discussing energy usage with customers.

CMP has also not been conducting root cause analysis on the complaints received. Nor has CMP instituted a process to categorize and analyze complaints aside from the categories that are assigned by the CAD upon referral.

6. Customer Bills

CMP bills for metered electric service and for several unmetered services, including area lights, line extensions, service establishment charges, temporary service charges, and pole charges. SmartCare also performs billing functions for supplier charges for Standard Offer Provider and Competitive Electricity Providers (CEP) accounts, consolidating delivery and supply charges. CMP's systems create and communicate transaction sets of customer usage and other information for the accounts of other Competitive Electricity Suppliers who bill their supply charges separately.

a. Preparing Customers for Bill Format and Content Change

An appropriate level of customer education to communicate upcoming changes to bill format, account numbers, billed-dates, and billing cycles comprises an important element of successful CIS deployment. CMP communicated pending billing changes prior to SmartCare deployment. However, customer communications concerning billing errors or bill presentation issues following deployment have not been timely, complete, or sometimes done at all. CMP conducted extensive focus-group and usability testing ahead of the new system to determine enhancements to the bill format. Focus group feedback suggested that customer happiness with the old bill and belief that it did not need to change. However, CMP designed a new bill format, expanding usage information and data display, enlarging font size for the amount due and due date entries, and incorporating a number of other information additions. CMP promoted the new bill design several times prior to and following deployment, as summarized in the next table.

New Bill Design Promotional Campaigns

Medium	Timing
CMP Web site promotion	July 7, 2017 (continuing)
Bill Inserts	August 2017
Social Media messages	August 2017 (weekly)
Bill messages	September 1, 2017 – January 31, 2018
Telephone On hold message	October 2017
Bill inserts	November 2017
CSR handout of bill changes	October 30, 2017

CMP intended the transition to the new system to be easy for customers. For instance, CMP enhanced its website so that either the old account number or new account number could access a customer's account. Unfortunately, CMP failed to communicate to customers prior to go-live that their account number was changing. A CMP bill with a new look and an unrecognizable account number was disconcerting for some customers.

A number of bill presentation errors were identified following go-live, including the first two listed below, which affected every customer bill printed or delivered electronically from January 30, 2018 through March 15, 2018.

- All bills issued from January 12 to March 15 presented an incorrect Late Payment Charge rate on the back of the bill.
- Bills issued from January 30 to March 2 with an average daily usage chart presented incorrect average daily usage information. The average daily usage displayed in the table for the month did not match the total usage divided by the number of days billed.
- Bills issued from November 1 through April 6 for customers with an interim meter reading displayed incorrect total KWHs usage (displayed usage based on the interim reading).
- On some bills issued from November 1 to March 7 the presentment of the asterisk symbol on the monthly usage chart was not shown for historical months when estimated meter readings occurred.
- Some bills issued on March 2 and 5 with an historical monthly usage bar chart presented missing bars.
- Some Net Energy Billing (NEB) customers received bills missing graphical data of their use and generation for the month of February.
- Regarding bills issued from November 1 to April 17 for customers on installment plans, a bill message referenced a past due installment in error when one plan ended and another began on the same bill.
- Bill message references an incorrect due date for some customers from December 29 to February 6.
- Customers with multiple meters billed on one account billed on June 1 received a bill with the correct number of kWh charged, but an incorrect meter display which caused the total data for all meters to be displayed for each meter, rather than individual data for each meter.
- CMP was also inconsistent in communicating with customers affected by these defects and communications explaining many of these defects were delayed months following the resolution. CMP communicated with customers using a variety of techniques based on type and severity of customer impact.

b. Billing Lag

Management uses revenue cycle billing, assigning customers to one of 20 billing cycles. The billing group creates a billing cycle schedule of required dates for meter read, bill extract, and bill print. Approximately two days before the billing cycle date, SmartCare requests the Meter Data Management system to load meter readings on the cycle billing date. The billing group also attempts to resolve any meter data exceptions. Completion of meter reading scrubbing and pre-calculation work sets the cycle up for bill calculation.

A SmartCare edit process reviews all accounts, calculates billing charges, and generates billing exceptions (EMMA cases, Outsorts, and Out of Balance) for any accounts requiring additional review or information. Executing this procedure ensures that customers' accounts contain the necessary information to render accurate bills. Specialists within the billing group manually review and correct these cycle billing exceptions, to allow bill issuance.

The last step creates bill and e-bill export files, encrypting and sending them to separate third-party vendors for mailing printed bills and electronic delivery of PDF e-bills. The billing group selects a monthly bill sample for manual recalculation to ensure correct SmartCare calculation.

Billing operation and maintenance (O&M) expenses increased by approximately 27 percent from 2016 to 2018, as the following chart shows. This increase is consistent with an organization that has transitioned to a new billing system.

Bill Processing Costs

Year	O&M Cost	Bills Issued	$ / Bill
2016	$2,953,526	7,250,122	$0.41
2017	$3,190,408	7,295,267	$0.44
2018*	$1,914,450	3,709,555	$0.52

*Through June 2018

The high level of defects and billing exceptions at go-live materially delayed bills to customers. Timeliness contributes importantly to minimizing the billing and payment cycle, and to supporting systems of communication with and about customers. Delay in customer bill generation can result in missing bills or bills that may be longer (in days billed) or shorter than customers are accustomed to receiving. Bills that have a higher number of days billed will be higher than a typical bill, and may result in customers perception of a "larger than normal" bill. Such atypical bills can raise the level of customer uncertainty and concern, which leads generally to increased inquiry and complaint volumes. We sought to verify customer bill issuance within an acceptable period following the gathering of customer usage information and account billing at least once monthly.

Chapter V describes our findings in testing billing accuracy. We used the same testbed to assess billing timeliness. We calculated a read-to-bill duration for bills in our testbed - - more than 3.9 million for the November 2017 through April 2018 period. We included all bills in our testbed for this analysis. To identify numbers of customers affected by delayed bills, we calculated read-to-bill performance (in days) for a variety of rate classifications and other groupings. The next table summarizes the results.

Over the six-month period, read-to-bill durations improved, with averages approaching norm by April 2018. However, several groups (most notably commercial customers) experienced significantly longer delays in receiving bills. The shaded areas in the table below indicate lengthy read-to-bill durations. Utilities strive to minimize read-to-bill duration, with a goal of same-day billing or within one to two days of read.

Read-to-Bill Durations (in Average Days) by Customer Group

Rate Groups	#Bills	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Avg.
Residential Service	3,480,070	3.0	3.7	2.3	2.0	1.7	1.6	2.5
Residential Time of Use	32,526	4.8	4.8	3.1	2.4	1.9	1.7	3.2
Load Management Service	1,403	18.4	10.3	6.3	3.4	1.3	2.2	9.4
Small General Service	365,527	9.6	9.8	5.8	3.0	1.9	1.4	5.7
Medium General Service	82,507	15.0	17.5	9.7	4.2	1.7	0.3	9.2
Intermediate General Service	2,029	27.3	35.0	22.5	10.2	4.9	1.7	20.1
Large General Service	1,836	62.0	48.7	39.2	21.6	20.6	4.2	60.3
Overall	3,965,898	3.9	4.7	2.9	2.2	1.7	1.6	3.0

We also looked for a correlation between the Complaint, High-Use, and High-Dollar customer subsets we used in examining metering accuracy. Complaint customers experienced higher average read-to-bill delivery times (in days), especially from November 2017 through February 2018, as the next table summarizes.

Read-to-Bill Ratios by Customer Sub-Group

Other Groupings	#Bills	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Av.g
Complaints	15,007	5.3	8.8	5.8	3.7	2.2	1.7	4.9
High Use	625,157	2.6	3.4	2.1	1.9	1.7	1.6	2.3
High Dollar	609,936	2.9	3.9	2.3	2.0	1.8	1.6	2.5

CMP has issued 95.2 percent of bills within five days of meter-read following SmartCare deployment. However, about two percent of customers have received bills delayed for a month or more. The next table shows volumes and percentages of delayed customer bills.

Delayed Customer Bills

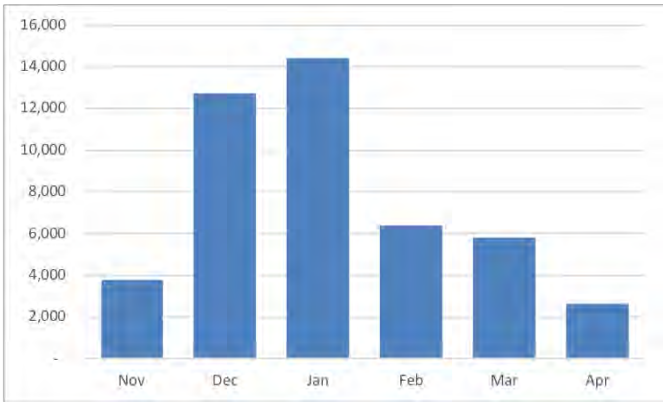
Bill Delay to Issuance	#Bills	%
0 to 5 days	3,775,923	95.2%
6 to 30 days	118,600	3.0%
2 months	43,007	1.1%
3 months	19,356	0.5%
4 months	7,117	0.2%
More than 4 months	1,787	0.1%

We also reviewed operational data to determine the number of bills held-up by billing exceptions or defects for each of the six months beginning with November of 2017. CMP's billing organization tracks billing performance daily and produces weekly reports indicating the volume of billing exceptions and delayed bills. Numbers of un-invoiced billing documents and bill prints

that are out-of-balance offer two important measures. The following chart depicts the volume of out-of-balance bills and other bill out-sorts during the months following SmartCare deployment. Out-of-balance are those identified in a bill validation routine as incorrect or not in balance. These bills are held for manual review and revision. Other bill validation routines identify billing errors at different points in the billing process, resulting in billing out-sorts or accounts that cannot be billed

Out-sorted billing documents and out-of-balance bills get held pending resolution of issues delaying their release. Both become delayed bills when not released within a five-day window of the billing cycle. Our analysis found substantial billing delays, experienced by thousands of customers in the months following the SmartCare implementation. The following chart depicts the volume of delayed bills, by month, due to billing out-sorts and out-of-balance bills.

Delayed Bills Due to Outsorts and Out-of-Balance

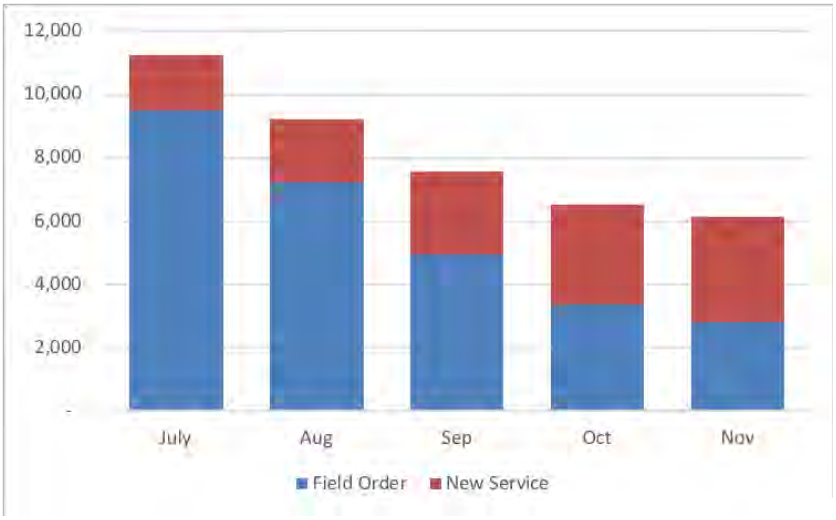


Other situations can delay the issuance of a customer bill. For instance, if the billing system does not have a meter reading for an account, the system will attempt to estimate usage and issue an estimated bill. However, if the system is unable to estimate usage or if the account has been estimated for three consecutive months, a reading must be obtained before a bill can be produced.

CMP has also experienced delays in setting up accounts for customers with new services or recently set or replaced meters. Since July 2018, the number of accounts awaiting account set-up has grown to more than 3,300. These customers are receiving service from CMP but have not received any bills, some have been waiting for as long as four months.

In July, more than 11,000 bills were delayed due to missing meter readings or other input that was needed from the field to complete billing. This number has dropped some by September, however, 8,000 bills were still awaiting field action. The next chart shows bills delayed awaiting field activity. The prior chart depicts bills delayed due to system issues, inability to calculate correctly.

Delayed Bills due to Missing Reads or Incomplete Account Set-Up



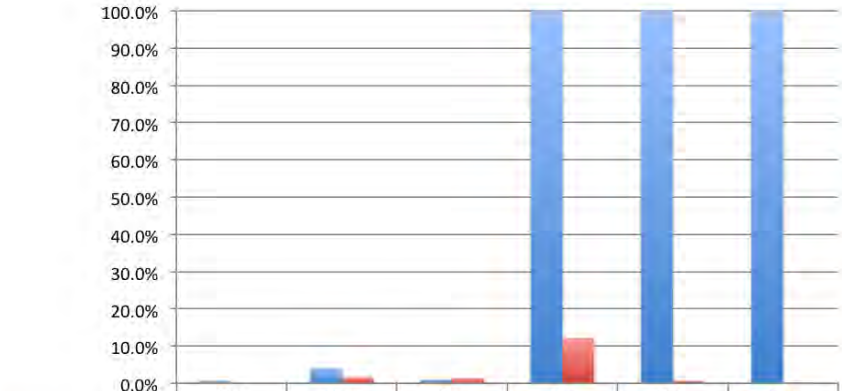
Management states that an increase in new service requests created additional workload for a diminished field clerical staff. CMP has supplemented staff with outside resources, and recently hired five additional staff to address these concerns, however backlog and delays in issuing bills is expected to continue through April 2019. Our analysis found substantial billing delays, experienced by thousands of customers in the months following the SmartCare implementation.

c. Billing Errors

Most utilities implementing new customer information systems experience billing issues post-implementation. CMP billing errors spiked after go-live, with several of the errors affecting an unusually large number of customer accounts. CMP has experienced struggles beyond the norm with billing issues following SmartCare go-live. System defects increased the work load for an already stressed and understaffed billing group. Defects in the SmartCare system identified post-go live produced bills with presentation errors or incorrect billing requiring correction and reissuance. Bill error rates rose following SmartCare deployment; they have since slowly improved, as management continues to address CIS-related issues and added resources to the Billing group.

Chapter 815 of the Commission's rules requires Maine utilities to notify the Consumer Assistance & Safety Division of billing errors affecting more than 10 customers. The Chapter also requires that a utility notify customers promptly in writing of a billing error after it discovers or is notified of the error. The following chart depicts the percentage of customers impacted by billing or presentation errors since November 2017.

Billing & Presentation Error Rate (Percent of Bills Issued)



	Oct	Nov	Dec	Jan	Feb	Mar
Presentation Error	0.8%	4.1%	1.1%	100.0%	100.0%	100.0%
Billing Error	0.0%	1.7%	1.5%	12.2%	0.7%	0.2%

Billing errors following SmartCare deployment created incorrect bills and rebills for inordinately large numbers of customers. We summarize those errors in a table in the appendix to this chapter. More than 100,000 customer accounts have had billing errors since SmartCare deployment. Additionally, all customer bills during January, February, or March of 2018 contained presentation errors as discussed above.

This chapter's appendix presents a timeline of these customer-facing defects. Many took months to resolve and CMP is still reporting customer-impacting errors, nearly a year after go-live.

d. Energy Manager

CMP's difficulty in making complete and accurate integration of Energy Manager functionality and information after SmartCare go-live promoted customer confusion. Energy Manager offers customers a self-service portal to examine detailed information about their energy use. CMP has promoted Energy Manager as an energy management tool for a number of years and about 13 percent of customers have enrolled in the portal. Energy Manager became unavailable to customers following SmartCare deployment at the end of October until December 5, 2017, returning then in a partial state. Delays occurred in loading historical meter usage data into the Energy Manager database. Energy Manager data became up-to-date and fully accessible to customers on December 12, 2017. Following that date, a number of defects and systems integration issues affected Energy Manager:

- Customers with two accounts saw no usage and cost information for the second account
- Customers enrolling over a weekend could not see their data for two weeks after enrollment
- Newly enrolled customers could not access Energy Manager
- Energy manager displayed graphical information incorrectly for multiple-meter customers
- Usage data loaded incorrectly for December 20th and 21st required replacement
- Some customers' usage and cost doubled the actual amount, or showed zeros.

Energy Manager's problems complicated contacts with customers about high bills.

The extended outage following the late October 2017 storm exacerbated the problems involving Energy Manager. Lost power to many AMI devices prevented daily readings for many customer

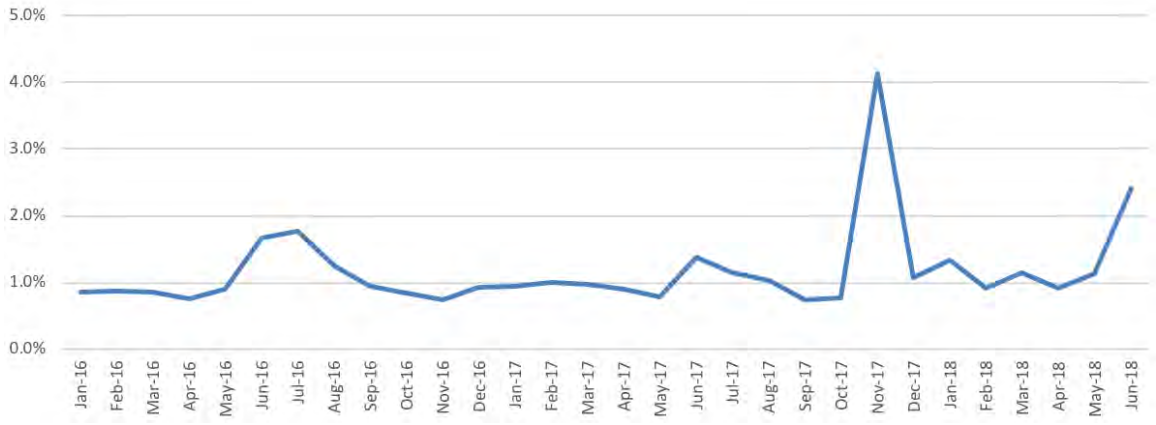
meters - - daily readings that Energy Manager employs. Energy Manager's hourly and daily usage graphs compensate for missing readings by spreading those readings available among the missing intervals or days. Energy Manager thus showed usage on days when customers had no power following the October storm.

Some customers accessing Energy Manager for the first time and even long-time Energy Manager users encountered problems and inconsistent meter usage information added to sources of customer questions and concerns.

e. Estimated Bills

Estimated bills can trigger customer inquiries and complaints, especially when the bill amounts vary noticeably from the prior month. The increase in the number of estimated bills issued in November 2017 drew attention to the new bill format, and likely increased customers inquiries. The efficiencies of an AMI network allow CMP typically to keep the numbers of estimated bills minimal. However, the October 2017 storm caused significant damage to the CMP distribution system and parts of its AMI network, making it difficult to gather all the required meter readings in the weeks following the storm. CMP issued nearly 24,000 estimated bills in November 2017, depicted as the peak in the following chart.

Percent of Bills Estimated



Customers registering complaints with CMP received estimated versus "read" bills at twice the rate of other customers during this period. The highest incidence of estimated bills for Complaint customers occurred from November through January. For more than 24,000 customers, the first bill received under the new SmartCare system used estimated usage following the storm.

CMP's SmartCare system estimates bills differently than the prior CIS, which some customers receiving estimated bills in the past may have observed. SmartCare bill estimation process (like that of the predecessor customer information system) does not take into account degree-day (temperature) impact. Estimating based on historical usage (same month, prior year) generally works best during normal weather. However, factoring for degree-days best addresses particularly cold or hot periods. Without adjustments for degree-day variances, usage gets under-estimated during cold spells, making the following month's bill (based on a meter read) look higher than

normal. The second bill "corrects" for apparently low prior month usage by producing apparently high second month usage.

7. Contact Center Operations

a. Performance Metrics

Customers call CMP's Contact Center for issues related to service disconnection, electric outage, billing, credit and collection issues, or to raise general questions. Management trains all customer service representatives to handle electric customer service and emergency calls. Electric emergencies, and customer reports of hazardous conditions, such as a wire down, get the highest priority, which includes routing the call to the first available representative. Outage and emergency calls are handled on a 24/7 basis, while billing- and account-related calls are handled from 7:30 am to 5 pm Monday through Friday. Calls specific to new-service connections are accepted between the hours of 7:00am and 4:00pm. CMP's IVR and web remain available at all hours.

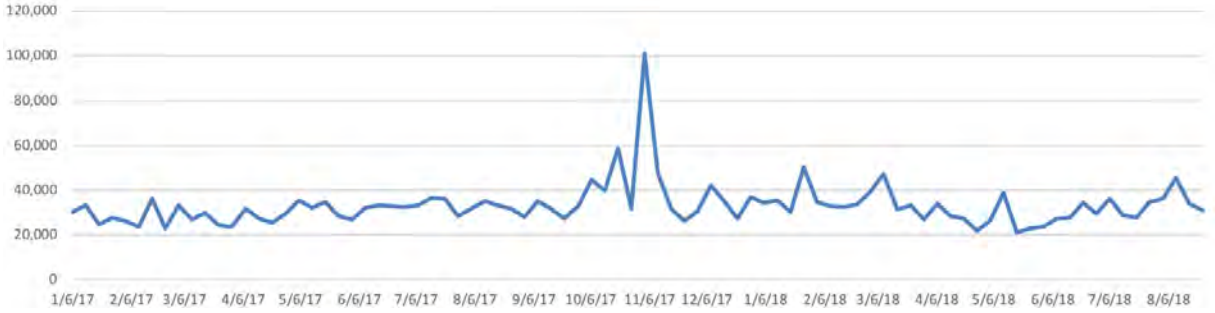
An Avaya Automatic Call Distributor (ACD) routes calls from the public telephone network. Calls get distributed by priority, type, availability, and agent skill. CMP received between 1.3 and 1.8 million calls yearly in 2016 and 2017 (including outage calls), with 2018 on a similar pace. The next chart depicts total calls received, those handled by CSRs, IVR, and callers abandoned.

Calls Received Annually

	2016	2017	2018
Abandoned	141,289	160,456	182,809
Answered IVR	223,837	229,955	141,262
Answered Outsource CSRs	598,914	488,632	242,486
Answered Company CSR	326,936	380,765	168,673

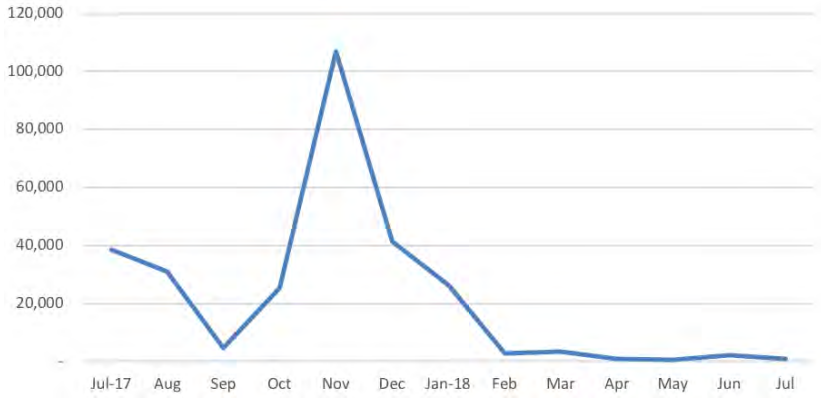
Call volumes increased before SmartCare go-live at the end of October 2017. The major storm coinciding with go-live also significantly increased call volumes. CMP closed customer service lines to normal business for four days, seeking to allow representatives to concentrate on helping customers who had lost power. When the center reopened for business, it experienced unusually high call volumes, as the next graph illustrates. Inexperience under the new SmartCare systems, processes, and interfaces, combined with insufficient staffing of the center, created longer calls, longer customer wait times, repeat calls, and high rates of call blockage.

Calls Received by Week



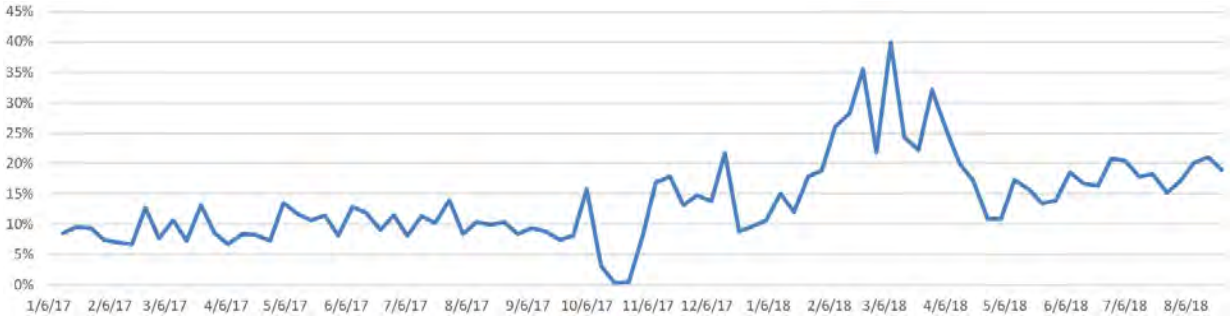
When training for SmartCare began in July 2017, management found that many customers dialing CMP got busy signals (were blocked). The number of customers attempting to reach CMP exceeded the capacity of trunk lines connecting the contact center to the telephone network. Management began tracking blocked calls in July 2017. Since then, nearly 350,000 customer calls have been blocked, with a peak of 112,710 in November 2017, following the October 2017 storm event. The worst blockage occurred from July 2017 to February 2018, during the pre- and post-SmartCare go-live periods. Call Center best practice eliminates instances of blocked calls through the use of overflow services or additional capacity.

Calls Blocked



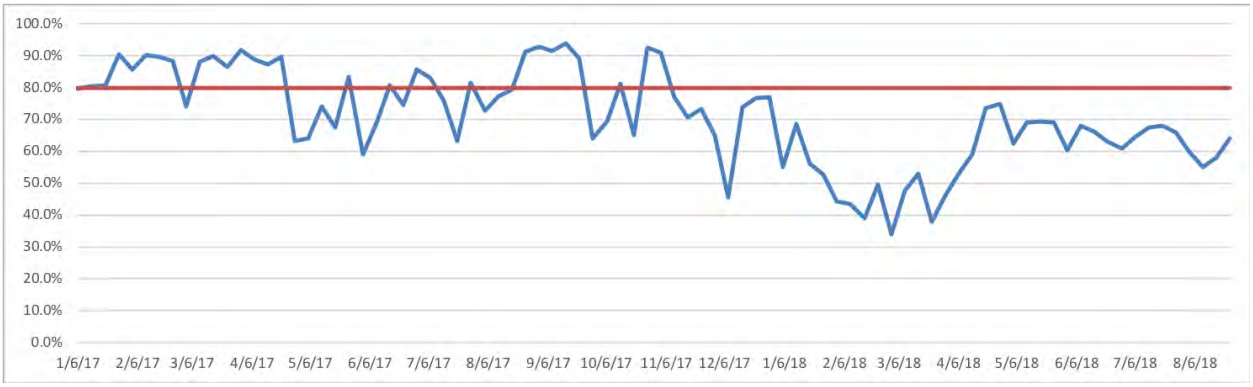
When all trunks become busy CMP delivers a message telling callers it cannot complete calls at that time. Numbers of callers abandoning before reaching the call center also increased significantly after go-live, peaking in late March and early April 2018, as the next chart illustrates. Typical industry abandonment rages fall between 5 and 10 percent. CMP experienced higher levels of abandons following go-live. However, the volume of abandoning callers is likely much higher than reported as many callers were blocked before even reaching CMP.

Percent of Callers Abandoning



Management uses an overall target of answering 80 percent of calls within 45 seconds, which conforms to industry experience. CMP's Call Center achieved its answering goal inconsistently, and experienced a significant drop in performance in November 2017, which continued through August 2018, as the next chart illustrates.

Percent of Calls Answered within 45 Seconds



Inexperience with the new customer system created longer calls, as seen in the chart below, which in turn created longer customer wait times, repeat calls, and the high call blockage.

Average Call Handle Times (seconds)

b. Internal and Outsourced Staffing

Staffing analyses conducted by Call Center management in February 2016 called for adding 35 permanent representatives to maintain adequate service levels for calls handled by employees in Maine. The analysis used projected call volumes and the expectation of answering 80 percent of calls within 45 seconds. A third-party out-of-state vendor was handling approximately 52 percent

of call volume then, with the automated calling system (IVR) handling another 19 percent of call volume. Management's work identified a gap of 25 representatives and anticipated a loss of 10 to attrition, thus producing a recommendation for 35 additional hires. Although a gap of 35 was indicated by the analysis, Call Center management only requested approval to hire 14 to address immediate concerns and to prepare for spring 2016 call volumes.

In June and July of 2017, CMP hired an additional 29 representatives to staff the Contact Center from SmartCare transition through longer-term stabilization. The group included 13 temporary employees and 16 full-time employees. The temporary employees were expected to remain through December 2017. CMP ended up keeping six of them longer, with some eventually becoming permanent employees.

A later resource analysis conducted in March 2018, four months following SmartCare go-live, recommended hiring 20 representatives, with the expectation of retaining 17 and of re-evaluating needs in the third quarter of 2018. Management did revisit call center staffing in July 2018, identifying a gap of 27 agents. In August, management subsequently approved the hiring of 25 additional staff.

Over the past three years, management has not always staffed to the recommended level.

Customer Service Representative Staff Additions

Period	Recommended	Actual
1Q 2016	35	14
2Q 2017	24	29
1Q 2018	29	20
3Q 2018	27	25

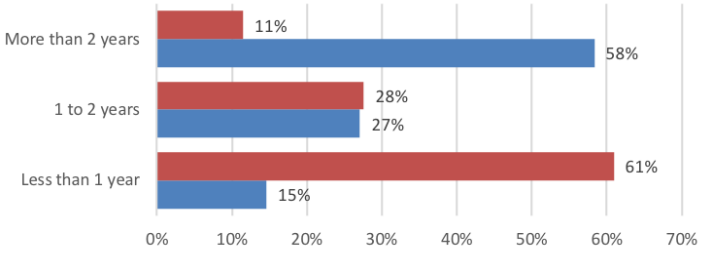
CMP has experienced very high turnover among outsourced representatives. CMP uses iQor, an international provider of such personnel. iQor typically handles calls for customers moving into or out of a location served by CMP and calls to discuss payment on overdue accounts. Call centers present a difficult and stressful work environment. On average, a call center employee will work about three to four years, producing an industry average annual turnover of 31 percent. Third-parties providing outsourced services to companies like CMP typically experience higher annual turnover rates of 49 percent. Turnover in CMP's Call Center increased in 2017, but remained within average for the industry. Outsourced representatives, however, have turned over at much higher rates. The next chart shows those rates for the last three years.

Customer Service Representative Annual Turnover

High attrition raises recruitment and training costs and can negatively impact service levels and call quality. It puts stress on management, trainers, and remaining employees who have to maintain service standards and quality.

CMP's outsourced representatives also show extremely short tenure. We compared the hiring dates of CMP and vendor-provided representatives. We found an average employee tenure of 6.9 years for CMP representatives (consistent with the industry), but less than a year for the outsourced representatives assigned to work CMP accounts. Remarkably, 24 percent were hired within the last 60 days from the date of this report. The next chart summarizes tenure information.

Comparative Representative Tenure



	Less than 1 year	1 to 2 years	More than 2 years
iQor	61%	28%	11%
CMP	15%	27%	58%

The turnover rates require the outside provider to replace from 7 to 13 CSRs each month, and essentially all of them within one year. With about a fourth of representatives just out of training at any given time, management is not providing a workforce conducive to consistent, high quality service to customers.

The lack of sufficient numbers of internal resources and the high turnover experienced among personnel provided by an outside firm have impaired Call Center operations. CMP's Call Center has not consistently achieved answering goals over the last two years, and suffered a very large drop in performance in July 2017 and again in May 2018. This metric is a primary driver of required staffing. Management has not staffed the Call Center sufficiently to keep call answering times at reasonably low durations. Adverse trends in blocked and abandoned calls and in call

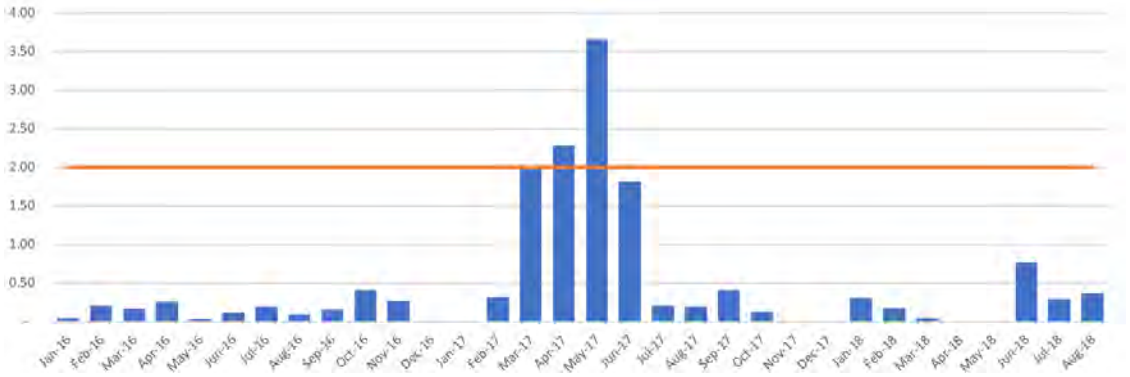
handling times also indicate staffing insufficient in total numbers and in those equipped by experience to handle more complicated issues with customers.

c. Monitoring and Training

Call quality monitoring proves essential in ensuring a good customer experience. Call quality monitoring serves across all major industries to monitor employee performance, primarily to identify gaps in training and to coach agent improvement. A lack of attention to this process can undermine call center performance and result in higher customer dissatisfaction. A primary objective of call monitoring is to identify the employees who could benefit from additional soft-skills training or a refresher of key concepts. Call quality monitoring reviews also reinforce technical training, especially during a transition to a new system.

CMP practices request call center supervisors to review at least two phone conversations with customers per customer service representative per month, to measure the quality of the conversation. CMP has not consistently evaluated the quality of customer service delivered over the past three years. The following chart details the reviews conducted since January 2016. CMP supervisors achieved the goal of two reviews per representative in only three months over the past three years, indicating a lack of commitment to monitoring call quality.

Call Quality Review Sessions per Representative



Call Center management reported that CMP supervisors have not had the time to conduct these quality reviews, given increased duties surrounding SmartCare deployment. Management resources normally assigned to these reviews instead had to provide training, agent support and customer issue resolution. CMP also lost three of its five supervisors during this period, as noted above, increasing the supervisory spans of control.

CMP provided SmartCare training to CSRs in mid-summer. With system deployment at the end of October, the resulting gap extended by more than three months, due to delays in launching the system. This lapse between training and go-live increased the difficulty for CSRs to retain concepts and requirements needed to make a smooth transition. Call quality monitoring should be a key management technique during post go-live, but it was not for CMP.

CMP Call Center management recognizes the deficiency in call quality monitoring sessions, and now expects more consistent supervisor execution of them going forward. In the interim,

supervisory and management feedback to agents has continued informally through occasional side-by-side call listening, coaching discussions based on errors identified and through shared learning to all employees, recognition from positive customer feedback, and reviews from informal management listening sessions.

Call quality monitoring also has substantial importance for third party call centers serving customers. CMP's source for third-party customer service resources has not consistently evaluated the quality of service delivered.

CMP's outside firm scores customer conversations under the quality standards that CMP uses. CMP expects the firm to participate periodically in calibration sessions with CMP personnel to ensure that the firm's supervisors evaluate call quality as CMP does. CMP's contract liaison conducts monitoring of the outside firm's calls as needed to support management of the contract. CMP has the right to ask for replacement of any call takers having below-standard quality evaluation scores. Additionally, CMP can invoke penalties if customer satisfaction levels fall below standard for calls handled by the outside firm's representatives.

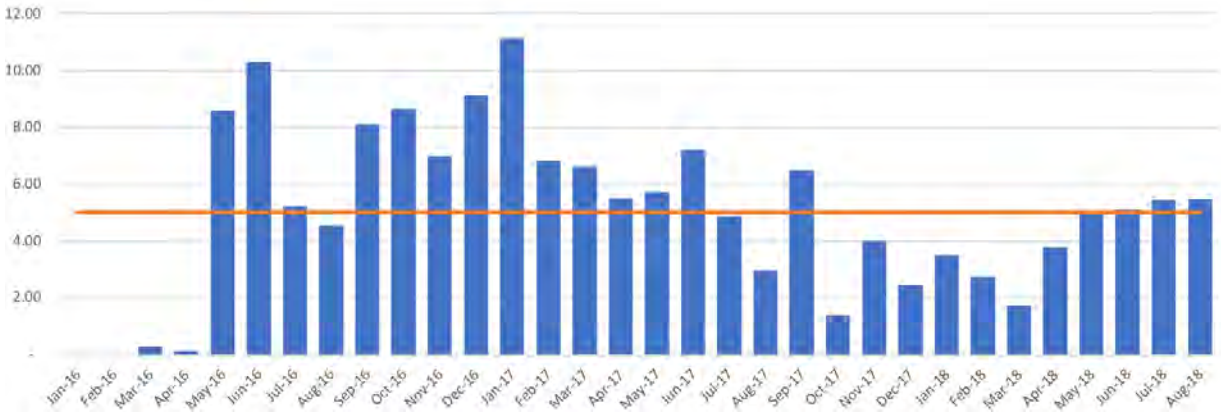
The next table summaries CMP's contract requirements, which call for 5 to 10 calls monitored per representative per month, based on employee tenure.

Contractor Monitoring Sessions

Length of Service, per call type	Minimum Sessions	Minimum Score
0 to 60 days	10 per agent	85%
2 to 6 months	10 per agent	90%
6 to 9 months	8 per agent	90%
9 to 12 months	8 per agent	90%
1 year or more	5 per agent	90%

Additionally, CMP can require at least one side-by-side monitoring session per quarter to establish a baseline for representative knowledge and ability to handle CMP calls. The following chart depicts the number of call quality monitoring sessions conducted per third-party employee since 2016.

Outside Call Quality Review Sessions per Representative



The outside firm has not met the five session per representative standard goal in at least 10 months over the past three years (not counting start up months of March and April 2016). We found it troubling that the outside firm failed to meet the standard in the each of the first six months following SmartCare go-live.

8. Agent-Assisted Credit/Debit Card Processing

The PCI Security Standards Council operates as a global forum for developing, enhancing, storing, disseminating, and implementing security standards for protecting cardholder account data and reducing credit-card fraud. The Council maintains Payment Card Industry Security Standards, and provides tools for implementation those standards. Its founding members include the largest participants in the industry: American Express, Discover Financial Services, JCB International, MasterCard, and Visa.

PCI DSS requirement 3.3 describes two means for risk mitigation: (a) requiring segmentation of call-center operations to minimize the number of agents with access to customer payment card data, and (b) suggesting the consideration of solutions under which the agent need not enter card information into the system. CMP offers customers the option of self-service credit and debit card payments through the IVR and the web. Customers can also pay by card with the assistance of a representative. All calls get recorded, for quality monitoring purposes. These calls include customer payment calls (CSR-assisted). PCI security guidelines seek to avoid recording/storing card validation codes in all cases and strongly discourage storing card numbers and expiration dates. CMP practices do not conform to these PCI security guidelines. Offering agent-assisted credit/debit card processing in the Contact Center increases PCI compliance and employee fraud risks.

Moreover, CSR-assisted credit/debit card payments are the costliest to process and the riskiest in terms of employee fraud. PCI DSS requirements and the need to encourage customers to use more cost-effective payment channels has led the utility industry in the direction of exclusive use of self-service credit/debit card payment processing, through the web and IVR.

C. Conclusions

1. Customer Complaints

Customer satisfaction, as measured by CMP's transactional survey, has declined since SmartCare deployment on October 30, 2017. Satisfaction levels in February 2018 fell below management's 85 percent goal, and have experienced significant periods of performance below that level since. Complaints rose dramatically following SmartCare deployment. Complaints spiked, remaining since at elevated levels and witnessing a number of additional spikes. Growth through the second quarter of 2018 evidences continuing difficulty in resolving: (a) specific complaints brought to CMP's attention, and (b) underlying issues still driving further complaint initiation. Management's inability to handle the billing circumstances following SmartCare operation began have contributed substantially to a climate of customer and public mistrust and skepticism, which accelerates complaint initiation.

Management has been unable to resolve customer inquiries and complaints in a timely manner. The days taken to contact customers seeking to raise inquiries or concerns and the days to resolve issues they raised spiked dramatically beginning in March 2018. The lack of root cause analysis of inquiries and complaints received has cost management the opportunity for more quickly identifying and solving systemic causes of complaints.

2. Billing Group Staffing

CMP management underestimated the duration it would take to stabilize SmartCare operation after it went live. The result was much more work in addressing billing errors requiring manual intervention and in finding and resolving system issues producing errors. In turn, therefore, management also underestimated the required numbers of Billing group personnel, leaving the group understaffed for the work required of it in the months following system deployment. Daily billing exception rates ran at twice the projected post-go-live level and about five times more than experienced under the system SmartCare replaced.

CMP management did not augment Billing group resources on a timely basis and it suffered the loss of two experienced personnel to an early separation offer curiously permitted to occur in the midst of SmartCare's early operations period.

3. Billing Timeliness

The high level of system defects and billing exceptions at go-live delayed customer bill issuance. Our examination of more than 4.3 million customer bills for November 2017 through April 2018 showed long durations from read to bill dates, with month-over-month improvement bringing average duration close to the norm by the end of the period. However, several customer groups experienced significantly longer delays - - most notably commercial customer groups. Our examination of the bills showed that customers who made billing complaints in the months after SmartCare go-live had higher read-to-bill delivery times (in days) from November through February. Particularly high levels of December and January bills were held-up before issuance due to identified exceptions or defects. Billing delays affected thousands of customers in the months following the SmartCare implementation.

4. Bill Information Accuracy and Clarity

Defects in the SmartCare system identified post-go live contributed to billing delays, and also produced bills containing accuracy or presentation error. Error rates were high following SmartCare operation but management has slowly brought about improvement as it has identified and corrected system errors and since added staff to address individual bills. More than 100,000 customer accounts have experienced billing error since SmartCare deployment and all first quarter 2018 bills suffered presentation error. Many individual customer billing errors took months to resolve. A year after go-live finds CMP still reporting customer-affecting errors.

Focus-group testing CMP conducted ahead of new-system introduction suggested customer satisfaction with bills they were receiving. Nonetheless, Management decided to change the format. CMP conducted a customer communications program to advise customers of coming changes, which included some website-access enhancements. However, CMP did not communicate to customers that their account numbers would change. The arrival of a new-look bill with an unrecognizable account number proved disconcerting for some customers. Moreover, a lack of sufficient bill-presentation testing before SmartCare go-live permitted a number of presentation errors to survive through first bills under the new system.

Factors like these added to customer confusion and concern about their bills, naturally promoting concern and even skepticism about the accuracy of billed amounts. Errors with Energy Manager proved significant. This feature allows customers to examine and analyze their energy use down to a daily level. With SmartCare go-live, Energy Manager did not become fully available to customers until December 5, 2017. It also contained a number of errors or omissions, some visible to customers and some not, during December and January.

5. Estimated Bills

A principal advantage of an AMI network is the extremely low need for estimated bills. CMP's number of estimated bills increased from one to over four percent (to about 24,000 customers) for November 2017, following the late October storm that caused significant disruption to its electricity delivery system and its AMI network. We found those customers making billing complaints twice as likely to have received estimated bills. Estimated bills generally tend to increase customer concern about accuracy.

Moreover, SmartCare bill estimation does not account for cold weather conditions. This absence produces (all else equal) an underestimate for a particularly cold period. The next bill that uses an actual reading will correspondingly appear high because it "catches" the usage that the previous month's estimated bill missed. Thus, the cold weather of the period following November 2017, combined with the inherently lower faith customers tend to place in estimated bills generally, combined to produce questions and concerns about billing accuracy.

6. Responsiveness to Customer Calls

Responding to customers begins with successful receipt of calls they make to the Call Center. Since July 2017, CMP had been experiencing an increase in customer calls blocked because call volume exceeded the capacity of trunk lines connecting the Call Center. A spike in blocked calls followed the October 2017 storm that came with the SmartCare go-live date. Significant numbers

of blocked calls continued into February 2018. CMP has also experienced a significant increase in the time it takes to handle calls following SmartCare go-live and CMP has also failed to meet consistently its target of answering 80 percent of customer calls within 45 seconds as it continued to struggle in the second and third quarters of 2018 to address customer billing issues.

7. Call Center Staffing and Supervision

Management's failure to maintain a hiring pace sufficient to meet growing Call Center needs contributed materially to CMP's inability to properly handle customer calls. With a 2016 analysis in hand showing a need and recommendation for adding 45 customer service representatives, management sought approval for only 14. As a result, call answering performance was below standard for much of 2016 and 2017. Management secured 16 full-time employees to support the transition to SmartCare and another 13 temporary employees it expected to keep until December 2017. It kept some of those temporary employees longer. These additional employees helped the Call Center improve call answering performance levels following post-go live. However increasing call volumes and handle times caused CMP's call answering performance to dip over the winter, spring, and throughout the summer of 2018.

The gap in needed numbers of personnel has been magnified by high turnover among outsourced call-center personnel. Within the industry, turnover among contracted call-center resources is about 50 percent per year. The firm employed by CMP far exceeds even this rate, requiring it to replace some 10 people per month, and essentially 100 percent of the force working for CMP within a single year. Their tenure is less than one year, one quarter hired within the last 60 days. Such high turnover makes it difficult to provide consistent, high quality service to customers.

An insufficient number of supervisors has also impaired CMP's ability to respond effectively to customer inquiries and complaints. The ratio of supervisors to representatives doubled (to 25:1) during the last several months of testing, training, and preparation for SmartCare go-live. Management did not add supervisors to cover increased numbers of representatives hired and it lost three experienced ones needed to provide experience, training, and direction at critical times leading to and following the switchover to SmartCare. Filling the three vacancies between April and July 2018 has reduced the ratio, but it remains somewhat higher than typical of the industry and the levels that existed in 2016 before growth in the number of representatives.

A structured program for evaluating the quality of representatives' performance in dealings with customers has suffered significantly from the lack of supervisory personnel. Established policy calls for the center's supervisory team to review multiple conversations with customers each month by each representative. Performance of these reviews since the summer of 2017 have been too infrequent - - in some months not occurring at all. The firm contracted to support CMP customer contacts also did not monitor its call quality performance at expected levels during the six months following SmartCare go-live.

8. Call Center Credit/Debit Card Processing

CMP's offering of agent-assisted credit/debit card processing in the Call Center increases PCI compliance and employee fraud risks. The PCI Security Standards Council, a global forum for security standards for protecting cardholder account data, has a standard for mitigating risk in call-

center processing of customer attempts to use cards for bill payment. CMP practices do not conform to these guidelines. The practices increase employee fraud risks for what is already a very costly processing method.

Chapter VII Appendix

Customer Impacting Errors Following SmartCare

#	Issue Name	Open	Closed	Communications to Customers Impacted	# Customers or Accounts	# Days to Resolve	$ VALUE	Type Error
1	Simple pay Conversion	11/6/17	1/3/18	1/3/18 (Added a line item on bill)	9,800	48		Conversion
2	Temporary Service Charge Rebilled at Conversion	11/7/17	11/21/17	4/10/18	23	14	$4,973	Conversion
3	Deposit Conversion	11/15/17	12/14/17	2/21/18	19	29	$363,487	Conversion
4	LPC On Deposits - Payment Arrangement Accounts	11/20/17	2/23/18	2/26/18	182	95	$1,077	Coding Defect
5	CEP Supplier Receivables	12/4/17	12/21/17		5,000	17	$428,611	Coding Defect
6	Set Up AMP in Conversion	12/5/17	1/3/18	3/15/18	27	29	$5,661	Manual Conversion
7	Summary Bill	12/6/17	3/6/18	3/6/18	69	90	$9,396	Code defect Bill Presentment
8	Net Energy Billing - High Generation	12/12/17	2/20/18	3/2/18	35	70	($11,059)	Code defect
9	Deposit Interest on Refund Checks	12/12/17	3/15/18	3/30/18	332	93	$3,351	Code defect
10	Deactivated Regular Payment Arrangements	12/18/17	12/28/17	3/30/18	1,350	10	$344	Code defect
11	ELP Enrollments	12/20/17	1/25/18	1/24/18	1,850	36	($249,389)	Code defect
12	Presentment: Bill Message Due Date for Selected Payment Arrangements	12/29/17	2/6/18		Not available	39		Code defect Bill Presentment
13	Underbilling/Presentment: Late Payment Interest Rate Change	1/2/18	3/15/18		58,177	72	($8,314)	Code defect Bill Presentment
14	Deposit Interest Rate Change	1/12/18	ongoing	ongoing	11,845	292	$914	Configuration
15	Underbilling - No Supplier Charges	1/17/18	4/27/18	7/6/18	108	100		Code defect

16	Underbilling - Landlord Customer Connect Charges	1/17/18	4/20/18		6,429	93	($77,148)	Code defect
17	Net Energy Metering - EDI Transaction for Dual Invoices	1/22/18	1/24/18	1/23/18	31	2		Code defect
18	Missed Supplier Enrollments at Conversion	1/25/18	1/29/18	1/30/18	55	4		Conversion
19	Presentment: Usage Information	1/30/18	3/6/18		Not available	35		Code defect
20	Presentment: Selected Interim Meter Readings	1/31/18	4/6/18		Not available	65		Code defect Bill Presentment
21	Deposit Refunds to Active Accounts - Suspended Until Complete	2/5/18		4/24/18	3,784	298		Code defect
22	Supplier Receivables Timing of Return to Supplier - Suspended	2/15/18	6/15/18	3/15/18	248	120		Code defect
23	Residentials Reverting Service to LL In Lieu Premise Visit	2/19/18	4/12/18	4/12/18	108	52	$6,484	Code defect
24	ELP - SmartCare Meter Discounted Opt Out Fee	2/20/18	Ongoing	3/1518	22		$157	Code defect
25	ELP - Area Light & Application Eligibility	2/23/18	4/30/18	3/20/18	22	66	$10,877	Code defect
26	Presentment: If 2 Payment Arrangements	2/23/18	4/17/18		Not available	53		Code defect Bill Presentment
27	Disconnected for NP Reverted To LL	3/1/18	4/5/18	4/5/18	45	35	$974	Code defect
28	Presentment: Asterisk Symbol On Chart	3/2/18	3/8/18		Not available	6		Bill Presentment Code defect
29	Smart Meter Opt Out Post Tenant Charge	3/5/18	12/12/18		102	282	$6,082	Code defect
30	Underbilling Me Green Power, Me Renewable Resource Fund	3/16/18	12/10/18	6/4/18	71	269	($1,454)	Code defect
31	CEP Supplier Payments - Applied To T&D	3/27/18	5/2/18		222	36	$25,386	Code defect
32	Presentment: Net Energy Billing Graph Issue	5/5/18	6/14/18	8/8/18	168	40		Bill Presentment Code defect

33	Manually Read Demand Customers Under Billed Demand Charges	4/19/18	4/19/18		61	0		Code defect
34	Presentment: Multiple Meter Bill Display	6/1/18	6/8/18	6/12/18	619	7		Bill Presentment Code defect
42	Estimation Issues with Meter Changes with Register Group Changes	9/13/17			Not available			Code defect
45	Balance Transfer Errors	7/11/18	7/31/18		51	20	$9,342	Code defect
46	Presentment: ELP Bill Message Errors	6/20/18	6/20/18		Not Available	-		Bill Presentment Code defect
47	Presentment: Multi-Month Bill Display Error	6/8/18	11/9/18		Not Available	154		Bill Presentment Code defect
48	SimplePay Not Started for Supplier Changes	5/17/18	7/25/18	7/25/18	14	69	$140	Code defect
50	Presentment: SimplePay and Payment Arrangement Bill Messages	8/1/18	8/13/18		Not available	12		Bill Presentment Code defect
	Total				**100,855**		**(324,562)**	