

# Evaluation of Advanced Metering System (AMS) Deployment in Texas

Report of Investigation

July 30, 2010



**Navigant Consulting (PI) LLC**

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July 30, 2010

Public Utility Commission of Texas  
1701 N. Congress Avenue  
Austin, TX 78711-3326  
Attn: W. Lane Lanford, Executive Director

**Re: Evaluation of Advanced Metering System (AMS) Deployment in Texas**

Dear Mr. Lanford:

Enclosed is a copy of the Report of Investigation prepared by Navigant Consulting (PI) LLC with regard to the above referenced matter.

Sincerely,

A handwritten signature in black ink that reads "Todd K. Lester". The signature is fluid and cursive, with a long horizontal stroke at the end.

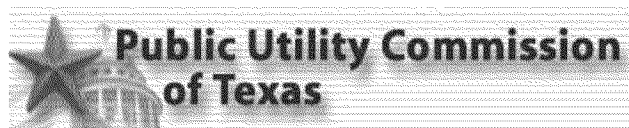
Todd K. Lester  
Navigant Consulting (PI) LLC

Enclosure  
CenterPoint Energy, Inc.  
Oncor Electric Delivery Company, LLC  
AEP Texas

EVALUATION OF ADVANCED  
METERING SYSTEM (AMS)  
DEPLOYMENT IN TEXAS

-

METER ACCURACY ASSESSMENT

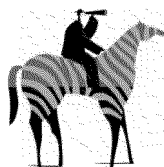


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July 30, 2010



## Introduction

Navigant Consulting (PI), LLC (, Navigant Consulting'), a subsidiary of Navigant Consulting, Inc., submits this Report of Investigation (, Report') to the Public Utility Commission of Texas (, Commission'). In accordance with the scope of work and terms of Navigant Consulting's respective engagement letters with the Commission and CenterPoint Energy, Inc. (, CenterPoint'), Oncor Electric Delivery Company, LLC (, Oncor') and AEP Texas Central Company and AEP Texas North Company (collectively , AEP Texas'), this Report presents the work performed in connection with the requested investigation into various aspects of advanced meters and advanced metering system (, AMS') deployment in Texas, including observations and findings of our work, as well as recommendations to enhance communication and further ensure the accuracy of customer billing pursuant to the deployment and use of advanced meters. It is our understanding that the Report will be disclosed to the general public.

Navigant Consulting has made its best effort, given the available time and resources, to conduct an impartial, independent and extensive investigation into various issues, questions and concerns raised regarding the deployment of advanced or , smart' meters and advanced metering systems by Oncor, CenterPoint and AEP Texas (collectively , Transmission and Distribution Service Providers' or , TDSPs') from their initial deployment following the adoption of the Commission's advanced metering rule in 2007 (, P.U.C. Subst. R. 25.130') through February 28, 2010 as requested.<sup>1</sup> This Report explains the substance of the most significant questions and issues investigated during our work including the meter accuracy, reliability and customer billing questions and concerns that were raised in connection with the respective TDSPs' deployment of advanced meters.

While the scope of our investigation has been broad, we did not conduct an exhaustive investigation into all aspects of advanced meters and advanced metering systems, or into all of the advanced meter complaints, as such an investigation would require time and resources beyond those reasonably required to address the significant questions that have been raised. We were not asked, and we have not attempted, to perform a detailed investigation into all of the challenges faced by each TDSP in the development of their advanced metering systems, nor the numerous business decisions, judgments and external factors that are involved in such large-scale deployments of new technology, communication and information management systems. In addition, many questions currently part of public discussion – such as questions relating to the security or privacy of advanced meters – are beyond the scope of our efforts in this investigation and this Report.

The Executive Summary is based on the set of facts, explanations and limitations described in the Report, and should be read with the Report itself. Standing alone, it does not, and cannot, provide a full understanding of the facts and analysis underlying our conclusions. In addition, while the Report itself is intended to provide the relevant basis for our findings, it does not exhaustively detail all of the efforts undertaken by Navigant Consulting.

<sup>1</sup> Public Utility Commission of Texas. Chapter 25. Substantive Rules Applicable to Electric Service Providers. Subchapter F. Metering. §25.130. Advanced Metering. Effective date 05/30/07.

## Overview of Navigant Consulting

**Navigant Consulting (NYSE: NCI)** – is an international firm of advisors and consultants with more than 1,900 professionals located across 42 offices in North America, Europe and Asia, including three (3) offices in Texas (Austin, Dallas and Houston). Navigant Consulting specializes in assisting major corporations, including electric utilities, their management, Boards of Directors, and inside and outside counsel in conducting high-profile consulting engagements and investigations, often involving significant challenges and operational problems. Navigant Consulting is a leading management consulting firm in the energy sector and works with many of the leading electric utility and power enterprises in the country, as well as regulatory commissions and other related entities undertaking efforts to develop and deploy smart grid initiatives including advanced metering systems.

**Licensure:** Navigant Consulting (PI) LLC is licensed by the Texas Private Security Board under license number A14814. Navigant Consulting is not a licensed accounting firm.

**Table of Contents**

**INTRODUCTION.....3**

**OVERVIEW OF NAVIGANT CONSULTING.....4**

**TABLE OF CONTENTS.....5**

**I. EXECUTIVE SUMMARY .....9**

    A. BACKGROUND .....9

    B. ADVANCED (, SMART') METERING DEPLOYMENT AND TRENDS.....9

    C. EXPECTED BENEFITS OF ADVANCED METERS AND ADVANCED METERING SYSTEMS..... 10

    D. IMPLEMENTATION OF ADVANCED METERING IN TEXAS ..... 11

    E. SCOPE AND OBJECTIVES OF THE INVESTIGATION ..... 11

    F. SUMMARY OF WORK PERFORMED ..... 13

    G. SUMMARY OBSERVATIONS AND FINDINGS..... 14

**II. BACKGROUND.....27**

    A. LEGISLATIVE AND REGULATORY HISTORY ..... 27

        1. Texas House Bill 2129 – Adoption of New Metering Technologies ..... 27

        2. Texas House Bill 3693 – Installation of Advanced Metering Systems..... 28

    B. ADVANCED METER DEPLOYMENT IN TEXAS..... 28

    C. EXPRESSED CONCERNS BY CUSTOMERS, TEXAS LEGISLATORS, THE MEDIA, AND OTHERS ..... 30

        1. Increased Incidence of Customer Complaints – “Higher Electric Bills” ..... 30

        2. Class Action Lawsuit (Oncor)..... 31

    D. RETENTION OF NAVIGANT CONSULTING..... 31

**III. SCOPE AND OBJECTIVES OF THE INVESTIGATION..... 32**

    A. AGREED SCOPE OF WORK ..... 32

    B. PUBLIC UTILITY COMMISSION OVERSIGHT..... 33

    C. OBJECTIVES OF THE INVESTIGATION ..... 33

        1. Is electricity usage accurately measured and recorded by the TDSP?..... 33

        2. Is electricity usage accurately communicated to the REP? ..... 33

        3. Is recorded electricity usage higher for customers with advanced meters?..... 34

        4. Are there other causes of meter-related customer complaints? ..... 34

    D. SUMMARY OF WORK PERFORMED ..... 35

        1. Overview of Work Steps ..... 35

        2. Document and Electronic Information Review and Analysis ..... 36

        3. Interviews of Key Personnel ..... 36

    E. INDEPENDENCE, INTEGRITY AND OBJECTIVITY ..... 36

    F. CONFIDENTIALITY OF CUSTOMER INFORMATION AND CRITICAL INFRASTRUCTURE ..... 37

    G. LIMITATIONS..... 37

**IV. OVERVIEW OF ELECTRIC UTILITY INDUSTRY AND THE “SMART GRID” .....38**

    A. ELECTRIC UTILITY INDUSTRY ..... 38

        1. Upgrading America’s Electric Power System (the “Smart Grid”)..... 38

2.	<i>What is the Smart Grid?</i> .....	39
3.	<i>What is an Advanced (i.e., “Smart”) Meter?</i> .....	40
4.	<i>Advanced (“Smart”) Metering Deployment and Trends</i> .....	40
5.	<i>Anticipated Benefits of Advanced Metering</i> .....	41
B.	<b>TEXAS TRANSMISSION AND DISTRIBUTION SERVICE PROVIDERS (TDSPs)</b> .....	42
1.	<i>Oncor Electric Delivery Company, LLC</i> .....	44
2.	<i>CenterPoint Energy, Inc.</i> .....	44
3.	<i>AEP North Texas Company and AEP Central Texas Company</i> .....	45
4.	<i>SmartMeterTexas.com</i> .....	46
<b>V.</b>	<b>ACCURACY TESTING OF ADVANCED METERS</b> .....	<b>47</b>
A.	<b>BACKGROUND</b> .....	47
B.	<b>PROJECT SCOPE AND TIMELINE</b> .....	47
C.	<b>ADVANCED METER TECHNOLOGY DEPLOYED</b> .....	47
D.	<b>APPLICABLE STANDARDS AND METER ACCURACY REQUIREMENTS</b> .....	48
1.	<i>Public Utility Commission of Texas</i> .....	48
2.	<i>American National Standards Institute (“ANSI”)</i> .....	48
3.	<i>National Institute of Standards and Technology (“NIST”)</i> .....	49
E.	<b>WORK PERFORMED</b> .....	49
1.	<i>Accuracy Performance Check</i> .....	49
2.	<i>Independent Testing of Advanced Meters</i> .....	50
3.	<i>Review of Historical Testing Procedures</i> .....	56
F.	<b>OBSERVATIONS AND FINDINGS</b> .....	57
1.	<i>Accuracy Testing of “New” and “Deployed” Advanced Meters</i> .....	57
2.	<i>Accuracy Testing of Advanced Meters in the Field (Field Testing)</i> .....	63
3.	<i>Side-by-Side Testing of Advanced and Electromechanical Meters</i> .....	64
4.	<i>Testing Results in Comparison to Manufacturer and Other Historical Tests</i> .....	67
5.	<i>Accuracy of Advanced Meters in Comparison to Electromechanical Meters</i> .....	68
6.	<i>Potential Impact of Meters Outside of Acceptable Accuracy Standards</i> .....	69
7.	<i>Overall Observations and Conclusions on AMS Meter Accuracy</i> .....	70
<b>VI.</b>	<b>EVALUATION OF ADVANCED METER DEPLOYMENT</b> .....	<b>71</b>
A.	<b>BACKGROUND</b> .....	71
B.	<b>WORK PERFORMED</b> .....	71
1.	<i>Advanced Meter Testing Process and Controls Review</i> .....	71
2.	<i>Advanced Meter Deployment Process and Controls Review</i> .....	72
C.	<b>OBSERVATIONS AND FINDINGS</b> .....	73
1.	<i>Oncor</i> .....	73
2.	<i>CenterPoint</i> .....	80
3.	<i>AEP Texas</i> .....	87
<b>VII.</b>	<b>CUSTOMER ELECTRIC USAGE / BILLING ANALYSIS</b> .....	<b>93</b>
A.	<b>BACKGROUND</b> .....	93
B.	<b>CUSTOMER BILLING PROCEDURES</b> .....	93
C.	<b>SCOPE OF WORK</b> .....	93

D. WORK PERFORMED .....	94
1. Identification of Advanced and Electromechanical Meter Population.....	95
2. Request for Customer Electric Usage / Consumption Data .....	95
3. Selection of Random Sample (Advanced Meters).....	96
4. Selection of “Matched” Control Group (Electromechanical Meters) .....	96
5. Data Standardization (e.g., Accounting for Variable Billing Periods).....	97
6. Structure of Electric Usage / Consumption Analysis Results.....	97
7. Statistical Methods Used .....	98
E. OBSERVATIONS AND FINDINGS – CENTERPOINT .....	100
1. Analysis of a Random Sample of Advanced Meters .....	100
2. Analysis of the Population of Advanced Meters.....	102
F. OBSERVATIONS AND FINDINGS – ONCOR .....	104
1. Analysis of a Random Sample of Advanced Meters .....	105
2. Analysis of the Population of Advanced Meters.....	107
<b>VIII. ANALYSIS OF CUSTOMER COMPLAINTS.....</b>	<b>109</b>
A. BACKGROUND .....	109
1. Complaints Filed with the Commission.....	109
2. Inquiries / Complaints Filed with the TDSPs and REPs .....	110
B. SCOPE OF WORK.....	110
C. WORK PERFORMED .....	110
1. Identification of Applicable Complaints.....	110
2. Correlation of Commission Complaints to TDSP Customers .....	112
3. Correlation of Matched Complaints to Advanced v. Electromechanical Meters .....	112
4. Analysis of Complaints.....	113
D. OBSERVATIONS AND FINDINGS.....	114
1. Frequency and Timing of Total Complaints.....	114
2. Analysis of Matched Complaints (Electromechanical v. Advanced Meters).....	117
3. Correlation of Oncor Matched Complaints to Heightened Media Coverage .....	122
4. Analysis of Specific Oncor Customer Concerns.....	123
<b>IX. METER DATA MANAGEMENT PROCESS AND CONTROLS REVIEW .....</b>	<b>129</b>
A. BACKGROUND .....	129
B. SCOPE OF WORK.....	129
C. WORK PERFORMED .....	129
1. Advanced Metering Infrastructure (AMI) Review .....	129
2. Advanced Meter Data Management Processes and Associated Controls Review .....	130
3. Meter-to-Bill Data Analysis .....	131
D. OBSERVATIONS AND CONCLUSIONS.....	132
1. Advanced Metering Infrastructure (AMI) Review .....	132
2. Advanced Meter Data Management Processes and Associated Controls Review .....	138
3. Meter-to-Bill Data Analysis .....	144
4. Meter to Back-End System Verification Analysis (On-Demand Read).....	152
<b>X. REVIEW OF IDENTIFIED ISSUES AND CORRECTIVE ACTIONS.....</b>	<b>154</b>



A. BACKGROUND .....	154
B. SCOPE OF WORK .....	154
C. WORK PERFORMED .....	154
D. OBSERVATIONS AND FINDINGS.....	155
1. <i>Oncor Related Issues</i> .....	155
2. <i>CenterPoint Related Issues</i> .....	168
3. <i>AEP Texas Related Issues</i> .....	169

## I. Executive Summary

Upon request, and under the direction of the Public Utility Commission of Texas, Navigant Consulting conducted an independent evaluation and investigation into various questions and concerns raised regarding the deployment of advanced metering systems in Texas by Oncor, CenterPoint and AEP Texas. Many of the issues investigated were in response to complaints filed with the Commission, as well as various media reports and inquiries, targeted at concerns over the accuracy of advanced or ,smart' meters currently being deployed by Oncor, CenterPoint and AEP Texas throughout their respective service territories. Many of the expressed concerns raised questions about a potential causal link between advanced meters and the observance of higher than expected electric utility bills by residential electricity customers in early 2010.

In accordance with the scope of work and terms of Navigant Consulting's retention agreements, the attached Report, including this Executive Summary, sets out the work performed by Navigant Consulting in connection with our evaluation and investigation, including the observations and findings resulting from our work.

### A. Background

Beginning with the passage of Texas House Bill No. 2129 (79<sup>th</sup> Legislative Session) in 2005, Texas Legislators encouraged the adoption of ,new metering and meter information technologies' by electric utilities in the State of Texas. The Commission subsequently undertook efforts to modify certain existing rules, as well as to create new rules, to address the use of advanced meters and the associated advanced metering infrastructure, which culminated in §25.130 *Advanced Metering* of the Commission's substantive rules.<sup>2</sup> Among other things, both Texas Legislators and the Commission were encouraged by the perceived benefits of advanced metering systems for Texas electric utilities and their customers including the potential for increased reliability, the use of dynamic pricing, improved generation, transmission and distribution, and more choices for electric customers.

In 2007, with the passage of House Bill No. 3693 (80<sup>th</sup> Legislative Session), the Texas Legislature expressed their interest that ,advanced meter data networks be deployed as rapidly as possible.' Among other things, advanced meters and advanced metering systems were expected to create savings and benefits to both the electric utilities and their customers from increased efficiency, reduced costs, enhanced transparency, and better customer service.<sup>3</sup>

### B. Advanced ("Smart") Metering Deployment and Trends

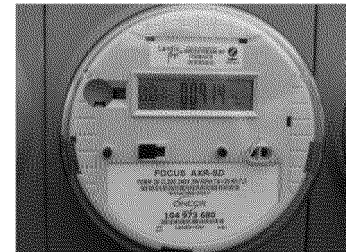
The shift to advanced metering systems and technology has been widely supported by the electric utility industry, as well as by legislative and regulatory bodies around the country. Much of that support derives from the significant perceived benefits to the utilities and their customers, not only from the deployment of advanced meters and advanced metering systems, but from the overall development of a ,Smart Grid'.

<sup>2</sup> The Commission adopted rule §25.130 *Advanced Metering* (the ,Advanced Metering Rule') in 2007.

<sup>3</sup> Public Utility Commission Report to the Legislature on Advanced Metering, September 2008.

Modernization of the electric power system, driven by advances in technology, is at the forefront of the so-called 'Smart Grid'. Loosely defined, the vision of the Smart Grid includes the digital automation of the entire power supply system from power generation to delivery to the customer for purposes of improving the *security, quality, reliability, efficiency and safety* of electric power, as well as promoting electric power that is more *environmentally friendly*.

Advanced meters, also commonly called 'smart meters', are one of the first steps in moving the electric power system toward the vision of the Smart Grid. Advanced meters are digital electronic metering devices that typically work just like a traditional electric meter – recording electric usage at a customer's home or business.



Advanced meters have been in development and use for many years, and are currently being introduced all over the developed world. It is estimated that over **70 million smart meters** are installed worldwide with over 250 million expected to be installed by 2015.<sup>4</sup> Major deployments are currently occurring in the United States, Canada, Japan, South Korea, Australia, New Zealand, and many parts of Europe. According to a recent report by the Edison Foundation, 38 states in the U.S. are currently pursuing deployment of advanced meters and almost 60 million advanced meters are expected to be installed and become operable over the next 10 years (by 2019).<sup>5</sup>

Transmission and distribution service providers (i.e., TDSPs) like Oncor, CenterPoint and AEP Texas are at the forefront of efforts nationwide by the electric utility industry to move toward a more technologically advanced method of measuring, recording and tracking customer electric usage – *some of the first steps toward the development of a Smart Grid*.

### C. Expected Benefits of Advanced Meters and Advanced Metering Systems

Once the advanced meters and advanced metering infrastructure are fully operational, consumers are expected to receive a number of potential benefits including: ***timely access to information, expanded product options and rate plans, improved service and reliability, reduced costs and service fees, and access to and control over their electricity use through in-home monitors and Home Area Networks.***

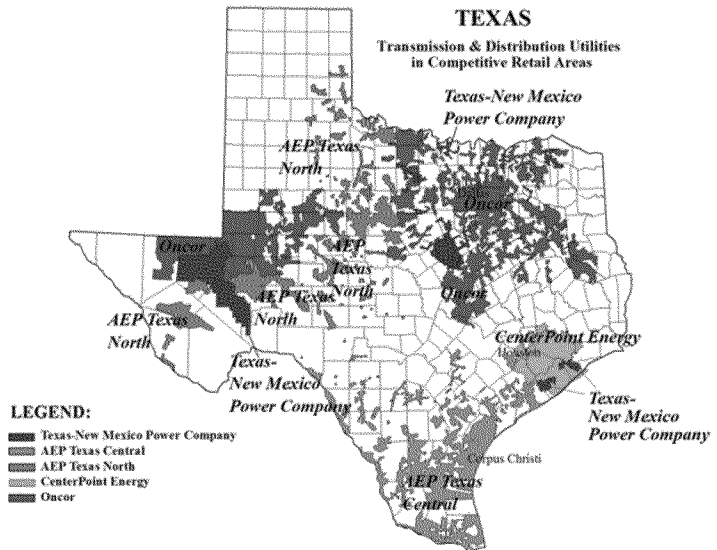
At the core of the expected benefits of advanced meters is more information. With the new advanced meters, it is expected that many consumers will be able to track their use of electricity in near real-time via the internet or an in-home monitor. Whereas electromechanical meters are manually read once per month, providing no information on when a customer used electricity during that month, advanced meters can be read instantaneously and are expected to provide information in 15-minute intervals. This equates to almost 3,000 reads per month – versus the one (1) read per month that consumers are currently used to. In addition, advanced meters are expected to provide data that will impact almost every major business function within a utility (e.g., billing, planning, operations, maintenance, customer service, forecasting, etc.).

<sup>4</sup> 'Smart Meters' from Pike Research, November 2009.

<sup>5</sup> Smart Meter Rollouts, The Edison Foundation, February 2010.

**D. Implementation of Advanced Metering in Texas**

Oncor is currently deploying Landis+Gyr Focus AXR-SD advanced meters to residential and commercial customers throughout its service area. As of June 30, 2010, Oncor has installed over one million advanced meters and is expected to complete installation of approximately 3.4 million advanced meters by the end of 2012. Oncor is currently recovering the costs of deploying advanced meters through a monthly service charge of \$2.19 per account, which is assessed on residential customers by their retail electric provider (, REP'). Oncor's system of integrated , smart ' technologies, including advanced meters, is called *Smart Texas*.



CenterPoint began installing Itron Centron advanced meters in February 2009 and is currently deploying advanced meters throughout its service area. As of June 30, 2010, CenterPoint had completed installing over 450,000 advanced meters and plans to complete installation of more than two million advanced meters across the greater Houston area by mid-2012. CenterPoint is currently recovering the costs of deploying advanced meters through a monthly service charge of \$3.05 per month, which was \$3.25 per month during the first two (2) years. CenterPoint's system of integrated , smart ' technologies including advanced meters is called *Energy Insight*.

AEP Texas began installing Landis+Gyr Focus AXR-SD advanced meters to its 1.1 million customers in November 2009. AEP Texas expects to complete deployment of advanced meters to its residential and commercial customers by 2013. As of June 30, 2010, AEP Texas has installed over 14,000 advanced meters. AEP Texas is currently recovering the costs of deploying the advanced meters through a monthly service charge to be collected as follows: \$3.15 per month from January 2010 to December 2011, \$2.89 per month for the following two (2) years, and \$2.26 per month from then until December 2020. AEP Texas' integrated system of advanced meters and advanced metering systems is called *gridSMART<sup>sm</sup>*.

**E. Scope and Objectives of the Investigation**

Responding to concerns expressed about the accuracy and reliability of advanced meters, as well in an effort to restore credibility in the advanced metering systems being deployed in the Texas competitive retail electric market, the Commission, in conjunction with Oncor, CenterPoint and

AEP Texas, retained Navigant Consulting to provide independent and objective analysis, investigation and evaluation of the advanced meters and advanced metering systems being deployed by the TDSPs in Texas. Navigant Consulting entered into separate, but similar, engagement letters with the Commission and each of Oncor, CenterPoint and AEP Texas.

Questions regarding the accuracy of advanced meters, as well as a potential link between higher electric bills observed by some residential customers and the deployment of advanced meters were an integral factor in the Commission's decision to retain an independent third party to evaluate the accuracy of the advanced meters being deployed. The main questions focused on the following:

- Is electricity usage accurately measured and recorded by the advanced meters?
- Is the recorded electricity usage accurately communicated from the advanced meters through the respective TDSP advanced metering systems for use in customer billing?
- Is recorded electricity usage higher on average for customers with advanced meters in comparison to customers with older electromechanical meters?
- Are there other potential factors or causes contributing to the observed higher incidence of meter and billing related customer complaints?

As a part of the evaluation and investigation, Navigant Consulting directed the independent testing of the accuracy of a large sample of advanced meters, as well as a review of complaints received by the Commission from residential customers with advanced meters who expressed concerns over their advanced meters and/or increases in their electric bills. Navigant Consulting also performed an independent evaluation of the advanced metering systems of each TDSP, including an evaluation of the transmission of customer electric usage information from advanced meters through the advanced metering infrastructure to that used for individual customer bills (i.e., meter-to-bill data flow). Navigant Consulting's scope of work included five major areas as follows:

1. Independent testing of the accuracy of advanced meters being deployed;
2. Investigation of customer meter and billing related complaints filed with the Commission that were made in relation to advanced meters;
3. Analysis of the historical electricity usage of customers with advanced meters versus customers who had yet to receive an advanced meter;
4. Evaluation of advanced meter testing, deployment and provisioning processes and controls; and
5. Evaluation of advanced metering infrastructure including the controls in place to ensure that electricity usage information is accurately communicated from the advanced meter to the market for billing purposes (i.e., meter-to-bill).

While each of these areas was applicable to both Oncor and CenterPoint, AEP Texas had only recently started its deployment of advanced meters and was still in the process of readying its advanced metering systems for use. As such, Navigant Consulting's efforts with AEP Texas were limited primarily to the independent testing of a sample of advanced meters, as well as an evaluation of AEP Texas' meter testing, deployment and planned provisioning processes.

The Commission provided oversight and direction of the independent investigation and evaluation conducted by Navigant Consulting. In addition to ensuring that a thorough and complete investigation was conducted, the Commission provided assurance that Navigant Consulting's efforts, and this Report, were not subject to any improper influence by the TDSPs, or other outside parties. A representative from the Commission was integrally involved in monitoring, evaluating, and providing input into the work steps performed by Navigant Consulting, as well as providing knowledge and expertise to help identify additional areas for review.

**F. Summary of Work Performed**

Navigant Consulting's investigation focused primarily on evaluating the accuracy of advanced meters deployed by the respective TDSPs and the reliability of the advanced metering systems and infrastructure at each TDSP to accurately and fairly report the electric usage of each customer. Our investigation also included efforts to address the reasons for the increased incidence of customer complaints and the perceived correlation of higher electric bills with the installation of advanced meters. While many questions and concerns have focused on issues of meter accuracy and higher electric bills, the investigation also expanded beyond these areas.

Navigant Consulting received the full cooperation of Oncor, CenterPoint and AEP Texas, and each has worked diligently to address questions and provide information requested by Navigant Consulting. During the course of the investigation, over 120 individuals from Navigant Consulting, the Commission, the respective TDSPs and various outside vendors and consultants have been involved pursuant to the objectives and scope of work as directed by the Commission.

During the course of the four-month long investigation and evaluation, Navigant Consulting independently tested over 5,600 advanced meters for accuracy and reviewed historical test results for accuracy on close to 1.1 million advanced meters and over 86,000 electromechanical meters. At our request, we were provided with over 18,000 pages of hard copy documents and files, including information provided by the Commission. In addition, Navigant Consulting had full access to electronic records available from each TDSP including records related to approximately 850,000 residential advanced meters already deployed, as well as up to four (4) years of historical electric usage records for over 1.8 million residential customers with either advanced or electromechanical meters. In total, we identified and analyzed approximately 345 million records (i.e., 40 Gigabytes) in potentially relevant electronic files.

Throughout the course of our work, we attempted to interview individuals who, to our knowledge, were likely to have significant information relevant to our evaluation and investigation. To that end, Navigant Consulting had access to over 60 individuals at the respective TDSPs, certain vendors, and Itron and Landis+Gyr (i.e., the advanced meter manufacturers) regarding the

applicable advanced meters, advanced meter deployment and provisioning processes, and the business processes and controls surrounding the TDSPs' advanced metering systems.

### G. Summary Observations and Findings

During Navigant Consulting's evaluation and investigation we have made various observations regarding the accuracy of the advanced meters being deployed, as well as the integrity and reliability of the processes and controls surrounding advanced meter deployment and the overall advanced metering systems of Oncor, CenterPoint and AEP Texas. However, as with the development and deployment of any large complex system, especially where new technology is involved, we did not expect to encounter systems and processes that were free of the need for improvement. Nor did we expect that each advanced meter and process would be 100% accurate and working efficiently and effectively.

Advanced meters and advanced metering systems are significantly more automated and complex than prior processes and systems involving electromechanical meters and manual meter readers. Regardless, advanced metering systems still involve significant human interaction to identify, evaluate, analyze and process information related to the operations of the advanced meters and the advanced metering systems. As such, there is a possibility of error and oversight, as well as inconsistencies and deficiencies that can always be improved. What is important in systems under development such as these are that processes, procedures and controls exist to quickly identify and address issues as they arise, and as those challenges are addressed new processes, procedures and controls are implemented to ensure that similar issues do not occur in the future.

While the scope of Navigant Consulting's work was not broad enough to evaluate every aspect of the advanced meters or advanced metering systems being deployed by the respective TDSPs, we feel that the nature of our work was sufficient to provide reasonable assurance to the Commission and others regarding the accuracy of the advanced meters in use and the effectiveness of the processes and controls around the deployment and use of advanced meters and advanced metering systems in Texas by the respective TDSPs.

***It is Navigant Consulting's opinion, with consideration given to certain issues described below, that the vast majority of advanced meters currently installed by Oncor, CenterPoint and AEP Texas are accurately measuring and recording electric usage, as well as communicating that information through the respective advanced metering systems for use in customer billing.***

However, it is important to note that our evaluation and investigation uncovered certain discrete groups of advanced meters that were not performing at acceptable levels, and where a certain number of customers appear to have been impacted. Further, it is apparent that any potential impact to customers from the observed advanced meter failures could have been limited, if not avoided entirely, if the respective TDSP had effectively monitored and analyzed the performance of these advanced meters given the information available to it.

It is also important to note that evaluation of some of these issues, as well as others described below and in this Report, is continuing and the potential impact to customers affected by these issues, as well as potential remediation where necessary, is continuing to be evaluated and processed. Of the issues identified by Navigant Consulting during our investigation, teams of individuals from the applicable TDSPs, as well as others as needed (e.g., representatives from the advanced meter manufacturers) have been quickly assembled to address these issues.

While we cannot guarantee that we have identified the extent of the advanced meter related issues that currently exist, or the potential of issues to develop in the future, the breadth and depth of our evaluation provides reasonable assurance that the existence of other potential issues is likely limited to either discrete groups of advanced meters or aspects of the applicable advanced metering systems that will not affect the day-to-day operations and services provided to the vast majority of customers with advanced meters.

Given the observations outlined below, as well as throughout this Report, we expect that each of the TDSPs will continue to develop, document and improve policies and practices to more quickly identify, evaluate and respond to potential advanced meter or advanced metering system issues, as well as individual customer questions and concerns.

The work performed and central observations and issues identified during our evaluation and investigation include the following:

*Accuracy Testing of Advanced Meters*

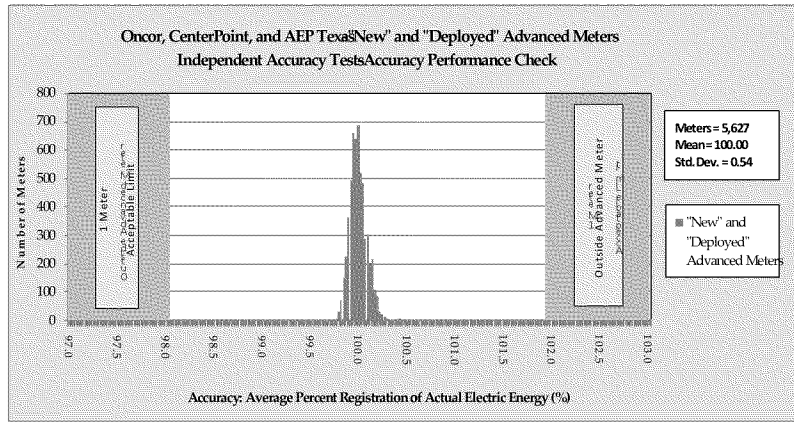
A central focus of Navigant Consulting's evaluation and investigation was in relation to allegations regarding the accuracy of advanced meters and the perceived failure of advanced meters to accurately record electric usage. During the course of our work, Navigant Consulting conducted independent accuracy tests on **5,627 advanced meters** in use by Oncor, CenterPoint and AEP Texas including testing **2,400 "New" meters** (i.e., meters not yet deployed), **2,706 "Deployed" meters** (i.e., advanced meters installed for some period of time that were removed from service for testing), and **521 meters** in the field (i.e., advanced meters still in service that were tested with portable test equipment).<sup>6</sup>

- Based on the results of the accuracy tests, **5,625 of the 5,627 meters (or 99.96%) were determined to be accurate** by ANSI standards. Not only were all but two (2) of the advanced meters accurate to within +/- 2.0% as required by the Commission, all but five (5) were found to be accurate to within +/- 0.5%, a performance standard expected by Oncor, CenterPoint and AEP Texas. Two (2) Oncor advanced meters did not meet ANSI standards of +/- 2.0%. In addition, three (3) advanced meters (two Oncor and one CenterPoint) did not meet Oncor and CenterPoint's expected performance of +/- 0.5%.

<sup>6</sup> At the request of Oncor, Navigant Consulting performed independent Field Testing of a sample of 521 advanced meters deployed in Oncor's service territory.

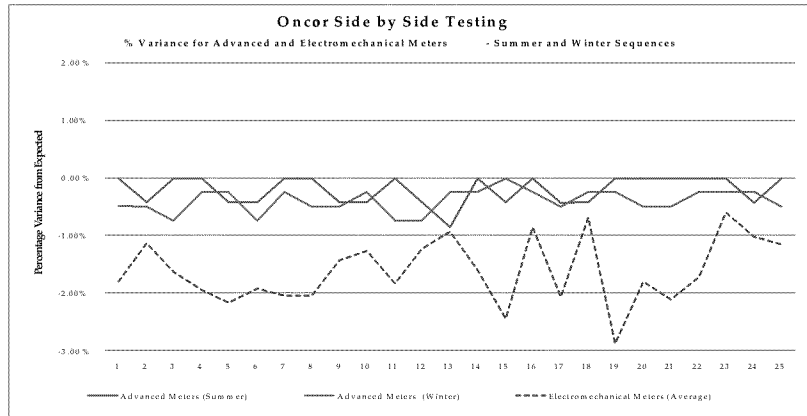


- Figure 1 displays a histogram of advanced meter accuracy test results for Oncor, CenterPoint and AEP Texas. Two (2) meters tested outside of ANSI standards of +/- 2.0%, based on an expected 100% accuracy.



- Navigant Consulting also conducted a limited number of comparison tests between 75 advanced meters and 75 electromechanical meters (i.e., Side-by-Side Testing) where the meters were subjected to the same load and temperature profile over a defined period to see what difference, if any, could be observed in the recorded electric usage by the different types of meters. While the testing was limited to a small sample of meters over a short time duration, with the exception of one (1) meter discussed below, we observed no questionable results with the advanced meters tested and generally observed that the advanced meters consistently performed better than the electromechanical meters.

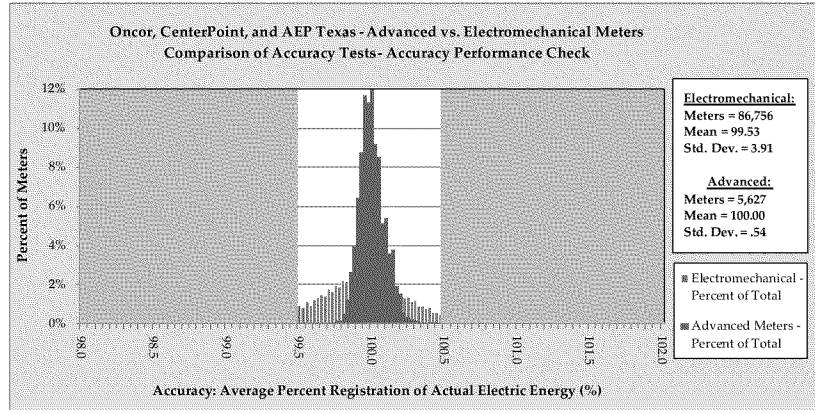
- Figure 2 displays an example of the Side-by-Side Testing results for 25 Oncor advanced meters and 25 electromechanical meters. The graph summarizes the observed percent difference in electricity usage.



- In addition to conducting independent testing of advanced meters, Navigant Consulting also evaluated the historical accuracy test results on 86,756 electromechanical meters tested by Oncor and CenterPoint. Of the meters tested, **3,594 meters (or 4%) failed** to meet ANSI standards of +/- 2% and **21,609 meters (or 25%) were outside the +/- 0.5% performance** criteria currently used by Oncor, CenterPoint and AEP Texas for their advanced meters.
- While electromechanical meters have long been considered reliable means of recording electric usage, the advanced meters being deployed by Oncor, CenterPoint and AEP Texas are significantly more accurate than the average electromechanical meters they are replacing. It is not uncommon for electromechanical meters to generally slow down over

time without adjustment and the average age of electromechanical meters still in service in the respective TDSP service territories is estimated to be over 20 years.

- *Figure 3* displays a histogram of the meter accuracy test results for 86,756 electromechanical meters tested by Oncor, CenterPoint, and AEP Texas in comparison to the 5,627 advanced meters tested in our investigation.



#### Customer Electric Usage / Billing Analysis

In addition to conducting independent testing of the accuracy of advanced meters, Navigant Consulting performed statistical analysis on the residential kilowatt hour (kWh) electric usage history of a random sample of customers with advanced meters in comparison to a random sample of customers that still had electromechanical meters. The objective of the analysis was to statistically evaluate whether customers with advanced meters experienced different (i.e., 'higher') metered electricity usage than they would have otherwise experienced without the advanced meter (i.e., whether advanced meters were affecting observed kilowatt hour consumption).

- Based on statistical analysis performed in relation to both Oncor and CenterPoint, we did not identify any statistically significant difference in electricity usage on average between customers with advanced meters and customers with electromechanical meters that we believe can be attributed to the installation and use of advanced meters.

#### Analysis of Customer Complaints

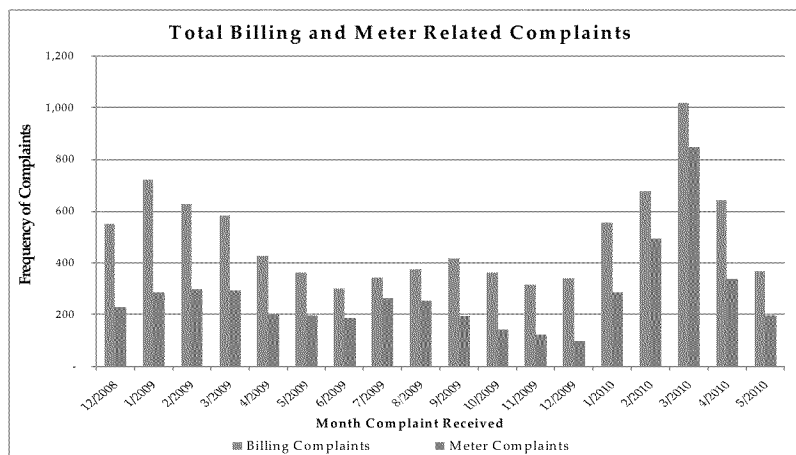
As part of our scope of work, we were also asked to analyze the increased incidence of customer complaints, especially in relation to concerns about higher electricity bills, and evaluate whether there was, or is, any relationship between the complaints and the deployment of advanced meters, the accuracy of the meters, or the accuracy of the associated billing process.

- Navigant Consulting evaluated a number of customer complaints filed with the Commission related to meter or billing related concerns, as well as a small number of specific concerns expressed by customers in Oncor's service territory. While we generally observed, and appreciated, the cause of the customer concerns and complaints, the vast majority of the higher electricity bills observed appear to be due primarily to significant changes in the weather and electricity usage during the recent severe winter in Texas. In addition, we observed a combination of other factors that may have exacerbated the observed differences in certain customer bills including the length of customer billing

cycles, as well as the use of ,estimated' and ,manual' meter reads that were either not reflective of the customer's actual electric usage, or inaccurate. In some instances, these issues aligned to create more significant impacts on customer electric bills.

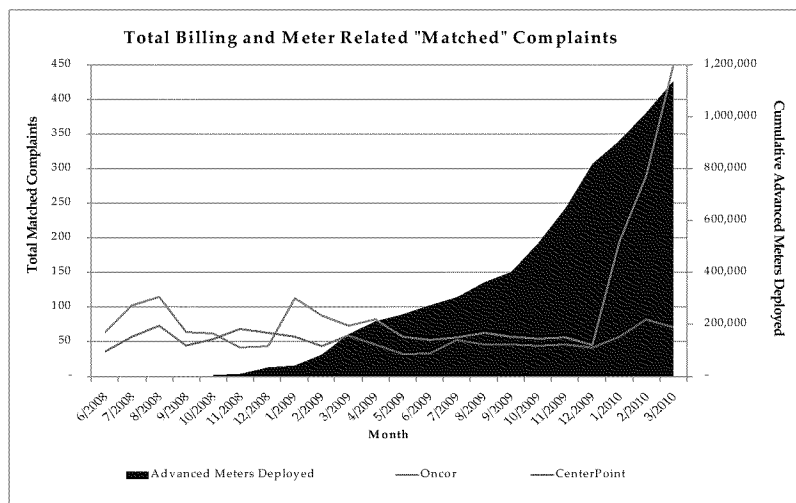
- Residential electric usage typically correlates directly to the increase and decrease in seasonal temperatures. The frequency of customer ,billing' and ,meter' related complaints observed by the Commission varies over time but also generally tends to increase following summer and winter months when electricity use can be at its highest. In early 2010, both overall ,billing' and ,meter' related complaints filed with Commission increased significantly, but then subsequently declined to more average levels by May.

- Figure 4* displays a bar chart of the number of ,billing' and ,meter' related complaints filed with the Commission between December 2008 and May 2010.



- In evaluating billing and meter related Complaints filed with the Commission, Navigant Consulting correlated the complaints to customers in Oncor or CenterPoint service territories, including customers with advanced meters. We identified approximately 951 complaints from customers in Oncor's service area with advanced meters and 87 complaints from customers in CenterPoint's service area with advanced meters. The vast majority of the identified complaints occurred in early 2010.

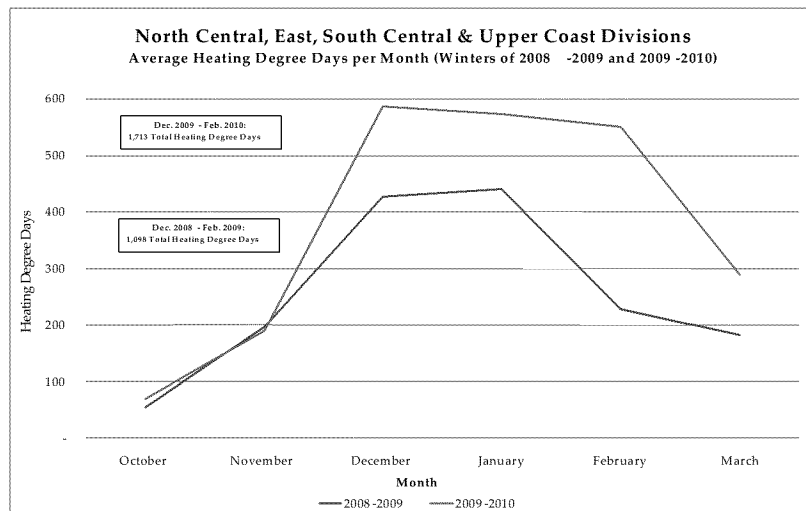
- Figure 5* displays a line and area graph comparing the frequency of customer complaints that were matched to either an Oncor or CenterPoint customer with an advanced meter. The total number of advanced meters deployed is depicted by the shaded area.



- The frequency of complaints from customers with advanced meters did not change significantly during the first 12 months of advanced meter deployment for either Oncor or CenterPoint. However, complaints from customers in Oncor’s service territory increased significantly in early 2010.
- As is typical in winter, customers with electric heat tend to see a significant increase in their bills resulting from the use of electricity to heat their homes. On the other hand, customers that use primarily natural gas for heating tend to see increases in their gas bills, but no corresponding change in their electric bills.
- While most people understand the impact on electricity usage when temperatures rise and fall, the electric industry also looks at the duration that temperatures remain above and below average. This is known as heating degree days (for winter) and cooling degrees days (for summer). While most appreciate that the past winter in Texas was one of the colder winters in recent memory, it was also unique because of the duration (i.e., days) of low temperatures. From a heating degree day perspective, the recent winter was over 56% colder on average than the previous year, roughly translating into 56% higher energy usage to maintain a household at a temperature its residents may have been accustomed to.

- *Figure 6* displays a graph of the average number of heating degree days in the Oncor and CenterPoint service areas during the past two winters (i.e., 2008-2009 and 2009-2010).

*The most recent winter had 615 more heating degree days.*



- Based on our evaluation of various customers with advanced meters who filed complaints with the Commission, we did not find evidence of inconsistencies, errors or other differences that could be attributed to the installation, accuracy or improper operation or functioning of the advanced meters. In many cases, the extreme temperatures experienced by most parts of Texas this past winter and the relative impact on customer electric usage, especially those customers with electric heating sources, combined with extended billing cycles and, in some cases, estimated and manual meter reads, contributed to a number of customers seeing a significant increase in electric usage that also coincided with the installation of a new advanced meter.

*Evaluation and Review of Advanced Meter Deployment and Meter Data Management Process and Controls*

One of Navigant Consulting's primary tasks in this matter also included an assessment of the processes, written procedures, and controls developed by each TDSP to facilitate the successful deployment and use of advanced meters in their respective service areas. Navigant Consulting focused on three distinct processes in the advanced meter deployment and integration effort including the initial testing and acceptance of advanced meters, the processes surrounding the physical deployment and installation of advanced meters, and the provisioning and approval of advanced meters for use by the TDSPs.

- We observed that the processes employed by the respective TDSPs were generally consistent with one another and sufficient to provide reasonable assurance that each TDSP had the necessary processes and control points to ensure the accurate deployment of advanced meters and that the meters were successfully communicating with the respective advanced metering systems.
- Another central focus of Navigant Consulting's investigation and analysis was whether advanced meters were accurately and consistently communicating electric usage from the meter to the electric utility for use in customer billing. Navigant Consulting evaluated each TDSP's advanced metering system including a review of the advanced metering infrastructure, an evaluation of the advanced meter data management process and associated controls, and an analysis to evaluate whether electricity usage information (i.e., register read data) is transmitted correctly from the advanced meter through the advanced metering systems of each of the TDSPs and ultimately for provision to the REPs for billing purposes (, Meter-to-Bill Analysis').
- Specifically, we traced over 270,000 daily and monthly register reads of customer electric usage for Oncor, CenterPoint and AEP Texas from 1) the advanced meters to the Head End system, 2) from the Head End system to the Meter Data Management System (MDMS), and 3) from the MDMS to the Customer Information System (CIS) to provide reasonable assurance that the daily and monthly register read information was communicated accurately. With the exception of one (1) unexplained variance that is still being evaluated, we noted no differences between the information measured and stored on the advanced meter and/or in the initial data storage system through the information ultimately used in the customer billing process.
- Navigant Consulting personnel also performed a Meter-to-Back-End System Verification Analysis (, On-Demand Read') to test the ability of the TDSPs to accurately read advanced meters remotely for approximately 657 advanced meters in service at the respective TDSPs. The On-Demand Reads were performed to ensure that the advanced metering system could communicate remotely , on-demand' with the advanced meters in the field.
- Approximately 85% of the On-Demand Reads attempted in the Oncor service territory were successful. Over 95% of the On-Demand Reads in the CenterPoint service territory and 100% of the On-Demand Reads in the AEP Texas service territory were successful.

- The majority (approximately 90%) of the unsuccessful On-Demand Reads were the result of a ,timed-out read', which meant that the TDSP was unable to remotely communicate with the advanced meter at the time the On-Demand Read was attempted. While we would not expect all advanced meters to remotely communicate ,on-demand' due to various issues with the communications network, some of which may be temporary, we nonetheless evaluated the cause of each unsuccessful On-Demand Read. In some cases the advanced meter was able to be contacted at a later point, while in others it was clear that the advanced meter had been communicating with the advanced metering systems to provide the required interval and register read data.

Review of Identified Issues and Corrective Actions

While our general observations regarding the accuracy testing of advanced meters and the associated processes and controls, as well as our analysis of historical electric usage and customer complaints should provide reasonable assurance that the vast majority of advanced meters appear to be functioning properly and that electric usage is being accurately measured, recorded, stored and communicated for use in customer bills, we did encounter advanced meters that were inaccurate, as well as processes and controls that are in need of improvement.

- During our testing of 5,627 advanced meters, Navigant Consulting identified two (2) advanced meters that were outside of the Commission's acceptable performance standards. One (1) advanced meter was running fast (i.e., at 139%) and the other was running slow (i.e., at 93%). Both meters were in Oncor's service area and were returned to Landis+Gyr for further evaluation and determination of the potential root cause.
- Upon joint investigation of the two (2) meters in question by Navigant Consulting, Oncor, Landis+Gyr and Luthan Electric Meter Testing, LLC (, Luthan '), several different issues were identified that were found to potentially impact a broader, but discrete, group of advanced meters.
- The root cause of the advanced meter found to be running fast was determined to result from poor quality workmanship in the manual soldering of a component to the advanced meter's circuit board. While the vast majority (i.e., ~90%) of the advanced meters deployed by Oncor do not have solder joints (i.e., they are fully integrated circuits), approximately 10% (or 120,000) advanced meters installed by Oncor in late 2008 and early 2009 were of a design (, Rev D') that required some hand-soldering of components. Upon further investigation, approximately 439 additional Rev D advanced meters (less than 0.4% of total Rev D advanced meters in service) were identified that exhibited a certain event code denoting a potentially similar issue. All but one (1) of these meters have been removed from service. Oncor is working with the customer to remove the final meter.

To date, 415 of these Rev D meters have been tested for accuracy with approximately 74 found to be outside the Commission's acceptable range of performance. The majority of these were found to be running fast. Oncor is in the process of remediating the potential over-billing of these customers. Oncor will not re-bill customers who may have been under-billed.

- A supplemental random sample of 250 Rev D advanced meters was subsequently tested for accuracy by Navigant Consulting with no other issues identified. One-hundred (100) of these meters, along with 61 other Rev D meters sent from Oncor to Landis+Gyr, were analyzed by Landis+Gyr under Navigant Consulting's direction including evaluation under a high-resolution microscope. While the observed quality of the hand-soldered joints in question was not encouraging, further testing, including accelerated life-testing being conducted by Landis+Gyr on some of these meters, has not resulted in additional failures to date, although reliability concerns still exist on a small number of these meters. Testing is expected to continue on these advanced meters over the next few months.
- In response to the identified potential advanced meter failures, as well as concerns over the quality of workmanship on these meters, Oncor refined a screening process in its advanced metering system to identify any other advanced meters exhibiting similar problems. While the observed meter failures are believed to be so-called 'early life events' (i.e., if the meter is going to fail, it will likely do so early in its life) Oncor and Landis+Gyr are confident that the refined system screen will be able to detect Rev D advanced meters that are not functioning properly so they can be removed and replaced within 24 hours of notification, and before any potential impact to the customer can occur.
- The other failed advanced meter identified during Navigant Consulting's accuracy testing also contributed to the evaluation of a subsequent set of advanced meters in service that may have exhibited similar characteristics. The slow meter in question was determined to result from a failed component within the meter known as the current transformer (CT). During Oncor's subsequent evaluations, Oncor identified a group of meters that had exhibited an event code denoting a potentially similar issue. A total of 989 advanced meters were removed from service and 839 have been tested. Approximately 64 of these advanced meters tested outside the range of acceptable performance standards. Of these, approximately 43 advanced meters have been confirmed to have a failed CT, the vast majority of which were running slow.

Oncor and Landis+Gyr are continuing to evaluate the potential root cause of the identified advanced meter issues but a significant number of the advanced meters evaluated with a failed CT also have evidence of potential tampering. Regardless, both Oncor and Landis+Gyr feel confident that advanced meters exhibiting similar characteristics can be quickly identified in the future and removed from service. Oncor has also implemented a screening and control procedure to quickly identify and remove these advanced meters from service, before they can have an impact on customer billing.

- During the review of issues associated with the advanced meters in question, Oncor launched a comprehensive effort to evaluate the various types of information communicated from the advanced meters each day, including certain event and error codes (i.e., red flags) intended to signal something has happened to the meter and/or that it may not be operating as expected. In the course of this evaluation, Oncor identified another group of meters exhibiting certain event codes similar to the Rev D meter that caused them to question whether the meters were performing as intended. Oncor subsequently

removed 831 ,Rev G' advanced meters from service and tested them for accuracy. Eleven (11) of these meters did not pass the accuracy test.

- Upon investigation, Landis+Gyr believes the variations in accuracy in the Rev G meters, as well as potentially some of the Rev D meters observed, result from a combination of very slight differences in the performance of certain components, that otherwise are operating within specified parameters. The combination of these factors in association with certain environmental factors is believed to lead to small variations in accuracy. However, as with the other issues identified, Oncor and Landis+Gyr are confident that this issue can be rapidly identified in the future with no impact to customers. Oncor is currently evaluating the necessary remediation to customers with the 11 meters that were potentially harmed. However, most of these meters were running slow, and thereby resulting in a small benefit to the customers potentially impacted.
- While a number of advanced meters have been identified that were not operating to acceptable performance standards, both Oncor and Landis+Gyr are confident that any future potential impact to customers with regard to these issues has been contained, that any advanced meters in service currently with these problems have been identified and removed from service, and that Oncor can effectively identify advanced meters with similar problems in the future and remove them from service before any customer impact.
- It is important to point out that although approximately 2,200 additional advanced meters were determined to have potential problems, only approximately 150 of those meters were found to be operating outside the range of acceptable performance standards at the time they were tested. Regardless, Oncor has removed all of the advanced meters in question from service and will continue to remove from service any advanced meter exhibiting similar characteristics within 24 hours.
- It is also important to note that even considering the full 2,200 advanced meters with potential issues described above, and the fact that the technology and operations of these meters are continuing to be improved, the observed problems impact less than 0.3% of the total population of advanced meters that have been deployed by Oncor – an amount far less than the observed 4% failure rate of the older electromechanical meters.
- Although the independent testing conducted during our work lead to the identification of advanced meters in service that were not performing as expected, in reality Oncor should have identified these meters sooner. While certain of the advanced meters described above only began to exhibit potential problems recently, others had been exhibiting , red flags ' and communicating potential problems to Oncor's Command Center for much longer periods of time – problems that generally appear to have gone unnoticed.
- One (1) advanced meter tested for AEP Texas also exhibited unusual and inaccurate performance. During the Side-by-Side Testing, where a random sample of 25 advanced meters and 25 electromechanical meters were simultaneously subjected to the same temperature and load profile for two (2) one-week test sequences (i.e., a winter and



summer sequence), one (1) of the advanced meters ceased to accurately record the amount of electric load applied to it. This meter has been returned to Landis+Gyr. AEP Texas, Landis+Gyr and Navigant Consulting are jointly investigating the potential root cause of this issue.

General Observations and Findings

- As with any technology, advanced meters will fail or cease to perform to acceptable standards for a variety of reasons. With traditional electromechanical meters, meter related failures or performance concerns are rare relative to the size of the population of meters deployed, but they are also not uncommon albeit in relatively limited quantities. The same is also true for advanced meters. The key, and an important difference however, is that electromechanical meters that cease to perform to acceptable standards may go undetected for long periods, even years, whereas in many cases problems with an advanced meter can be detected relatively soon, if not immediately, after problems arise.
- If an advanced meter is not performing to acceptable standards, there is a high probability that the meter will communicate an event or error code (i.e., a red flag) signaling a potential issue – *the advanced meter will tell us that something is wrong.*
- In addition, repeated communication problems between an advanced meter and a TDSP's advanced metering system, especially when an advanced meter ceases to communicate, also may be symptomatic of problems with the proper functioning of the advanced meter. While advanced meters may have trouble communicating for a variety of reasons including that the meter is located in an area where the communications network is not fully developed, communication issues with advanced meters that otherwise should be communicating could be indicative of more serious issues with the advanced meter itself.
- Historically, utilities would only interact with an electric meter once per month, sometimes more if service was being connected or disconnected or other issues needed to be addressed. However, with advanced meters, the utility can interact with the meter multiple times throughout the day and advanced meters are capable of communicating a variety of messages and other codes regarding how the meter is performing, as well as whether any issues occurred (e.g., power outages, other) since the last communication.
- The TDSPs should be aggressively monitoring the information communicated by the advanced meters and correlating that information to potential problems with the proper functioning of the meters, as well as whether the meter is effectively and consistently communicating with the utility as expected. Aggressive identification, investigation and analysis of meter information could have prevented the Oncor meters from being in service for extended periods when they may not have been operating within acceptable performance standards.
- The TDSPs should continue to develop, improve and monitor processes and controls surrounding the effective identification, analysis and prompt evaluation of either identified event codes or meter communication problems that may be characteristic of larger errors or

issues once advanced meters have been approved for use and in service for some time. As noted with Oncor, they appear to be following clearly defined processes and procedures with applicable controls in the initial testing, deployment and provisioning of advanced meters, but the processes and controls are less defined around addressing operational problems with the advanced meters once they are in service.

- We also generally observed that broader (i.e., systemic) problems typically correlate with the type of meter hardware or version of firmware in use, as well as with advanced meter communication issues. The TDSPs should identify, document and monitor advanced meter performance relative to the meter type and firmware version including which meters are not operating with the most current firmware version, as well as which meters are not communicating with the TDSP or are experiencing periods of inconsistent communication. With Oncor, we generally did not observe a robust evaluation of meter related failures or issues being cross-referenced to these broader categories, which could facilitate identifying the possibility of broader systemic issues when they occur.
- Advanced meters that either fail to communicate or demonstrate inconsistent communication, when they otherwise should be communicating, potentially may be exhibiting symptoms of a larger issue and should be proactively addressed by replacing the meter and conducting a more in-depth root cause analysis. While the Commission's substantive rules allow for up to three (3) consecutive estimated bills (citing the inability to , gain access to the premises' as a potential reason), there does not appear to be a reasonable basis for allowing an advanced meter that is not effectively communicating with its advanced metering system to remain in service or unchecked for such a length of time.
- While some evaluation appears to have been performed on advanced meter failures in the past, it is important for the TDSPs at this stage of advanced meter and advanced metering system deployment to conduct routine root cause analysis and follow-up with the manufacturer on meter related failures. Although employing significant resources in the evaluation of every meter with an error code or communication problem would not be either efficient or cost-effective to the TDSPs and their customers, a defined process with appropriate thresholds and procedures could avoid similar problems in the future as those currently experienced by Oncor.
- Despite the observed inaccurate performance of a small number of Oncor advanced meters, it does not appear that the vast majority of the advanced meters operating outside of acceptable performance standards resulted in a significant impact to customers from one month to the next. First, many of the identified issues appear to have been intermittent where the meter may have operated within acceptable performance limits for significant periods of time before exhibiting a problem, and then subsequently may have self-corrected. Second, many of the identified problems were consistent with the advanced meters running slower than expected, which would have benefited the customers during those periods.

During the course of our investigation and evaluation, we observed certain key aspects of the advanced metering system, as well as the advanced meters that require special attention as the TDSPs continue to develop, improve and monitor the processes, procedures and controls associated with the advanced metering systems, including the following:

- **Importance of Addressing Advanced Meter Communication Issues –** Continue to develop, document and improve policies and procedures to evaluate advanced meters with communication issues (especially advanced meters that suddenly cease to communicate) quickly as communication issues are typically symptomatic of more serious issues with the advanced meter itself. Categorize and analyze communication issues in relation to advanced meter version including hardware components and firmware installed.
- **Importance of Monitoring Event / Error Codes Communicated by Advanced Meters –** Continue to develop, document and improve policies and procedures to evaluate the event / error codes communicated from the advanced meters including developing a detailed understanding of the codes, as well as defining thresholds for analysis and reporting purposes. Categorize and analyze event /error codes in relation to advanced meter version including hardware and firmware versions installed. There is a high probability that the advanced meter will communicate an event or error code signaling a potential issue if the advanced meter is not performing to acceptable standards.
- **Importance of Performing Root Cause Analysis on Advanced Meter Failures –** Continue to develop, document and improve policies and procedures to evaluate the root cause of advanced meter failures especially where failures seem to be concentrated in a particular advanced meter hardware or firmware version.
- **Importance of Evaluating Success / Failure Rates of Firmware Upgrades –** Continue to develop, document and improve policies and procedures to evaluate the success and failure rates for the deployment of firmware upgrades as advanced meters that are allowed to remain in service for extended periods with old firmware versions are likely more susceptible to potential issues.
- **Importance of Establishing Cross-Functional Teams to Evaluate Advanced Meter Communication Problems and Failures, as well as to Monitor Event / Error Codes and Success / Failure Rates of Firmware Upgrades –** Continue to develop and educate cross-functional teams including representatives from the information technology, metering, billing, and customer service departments to coordinate and evaluate the potential impact of any issues related to advanced meters or the advanced metering system upon meter reliability, meter accuracy, and billing accuracy.

## II. Background

Electric utilities under the regulatory authority of the Public Utility Commission of Texas began installing advanced or smart meters in late 2008. Oncor was the first utility in Texas to begin mass deployment of advanced meters to its approximately 3.4 million residential and non-residential retail electric customers. Oncor was followed by CenterPoint who began deploying advanced meters to its approximate 2.4 million residential and non-residential retail electric customers in early 2009. AEP Texas began initial deployment of advanced meters to approximately 1.1 million customers in November 2009.

The shift to advanced metering systems and technology has been widely supported by the electric utilities, as well as by the legislative and regulatory bodies of the State of Texas. Much of that support derives from the significant perceived benefits to the utilities and their customers that are expected from the advanced meters and metering systems being installed by utilities nationwide, and the overall development of the Smart Grid.

In early 2010, certain customers who noted a significant increase in their electricity bills began to complain to the Commission and others questioning a possible connection to the advanced meters being deployed. TXU Energy and Reliant Energy (large retail electric providers in Texas) also noted increases in customer complaints regarding higher electric bills, much of which however, was blamed on an abnormally cold winter in Texas.<sup>7</sup> Similar complaints were also being waged in California by customers of Pacific Gas & Electric Co. (PG&E), who began installing advanced meters in 2006 and who leads the nation in the deployment of advanced meters with almost six million currently in service.

Responding to concerns raised by electric customers, the media, Texas legislators and others, the Commission engaged Navigant Consulting to conduct an independent investigation and evaluation of the advanced meters and metering systems being deployed in the Texas competitive retail electric market.

### A. Legislative and Regulatory History

#### 1. Texas House Bill 2129 – Adoption of New Metering Technologies

With the passage of Texas House Bill 2129 (H.B. 2129 - 79<sup>th</sup> Legislative Session), Texas Legislators acknowledged the importance of advanced metering systems and encouraged the adoption of these technologies by electric utilities in this state \*Texas\*. More specifically, H.B. 2129 stated that:

*“...new metering and meter information technologies, have the potential to increase the reliability of the regional electrical network, encourage dynamic pricing and demand response, make better use of transmission and generation assets, and provide more choices for consumers...”*

<sup>7</sup> Spike in electric bill shocks area customers, Temple Daily Telegram, February 5, 2010.

Following the guidance of the Texas Legislature, the Commission developed new rules to address advanced meters and advanced metering infrastructure. The Commission adopted rule §25.130 *Advanced Metering* in May 2007 (the , Advanced Metering Rule'). The Advanced Metering Rule laid out the various policies and requirements related to the deployment and use of advanced metering systems by electric utilities in Texas.<sup>8</sup> The Commission subsequently opened Project No. 34610 *Implementation Project Relating to Advanced Metering* to promote and provide guidance for the deployment of advanced metering systems in Texas.

Among other things, the Commission's Advanced Metering Rule encouraged the deployment of advanced metering systems for the purposes of *i) increasing the reliability of the electric network; ii) encouraging the use of dynamic pricing and demand response; iii) improving the deployment and operation of generation, transmission and distribution assets; and iv) to provide more choices for electric customers.*<sup>9</sup>

## 2. Texas House Bill 3693 – Installation of Advanced Metering Systems

Texas Law HB 3693 (80<sup>th</sup> Legislative Session), signed in 2007, amended the Texas Utilities Code - Section 39.107 to expedite the installation of advanced metering systems by investor-owned TDSPs in the ERCOT market, as follows:<sup>10</sup>

*“(i) Subject to the restrictions in Subsection (h), it is the intent of the legislature that net metering and advanced meter information networks be deployed as rapidly as possible to allow customers to better manage energy use and control costs, and to facilitate demand response initiatives.”*

The TDSPs with this requirement were CenterPoint, Oncor, AEP Texas and Texas-New Mexico Power Company (, TNMP').<sup>11</sup>

### B. Advanced Meter Deployment in Texas

#### Oncor

On May 28, 2008, Oncor filed an application with the Commission (Docket No. 35718) seeking approval of an Advanced Metering System (AMS) deployment plan and request for a surcharge to recover the costs of deployment pursuant to that plan.<sup>12</sup> Oncor's plan provided for the full deployment of advanced meters by the end of 2012 to over 3.4 million residential and non-residential retail electric customers in Oncor's service area. Oncor's plan, as revised, was approved by the Commission on August 29, 2008.<sup>13</sup>

<sup>8</sup> Commission Substantive Rules on Advanced Metering §25.130, (a) Purpose, and (d) Deployment and use of advanced meters.

<sup>9</sup> Commission Substantive Rules on Advanced Metering §25.130.

<sup>10</sup> Texas HB 3693, Section 20.

<sup>11</sup> TNMP filed Notice of Deployment of an Advanced Metering System to the Commission on 5/26/2010.

<sup>12</sup> Oncor Electric Delivery Company LLC's Request for Approval of Advanced Metering System (AMS) Deployment Plan and Request for Surcharge (Docket No. 35718).

<sup>13</sup> Order in relation to Oncor Electric Delivery Company LLC's Request for Approval of Advanced Metering System (AMS) Deployment Plan and Request for Surcharge (Docket No. 35718).

Oncor began deployment of advanced meters in November 2008.<sup>14</sup> As of May 2010, Oncor had deployed approximately one million advanced meters.<sup>15</sup>

CenterPoint

On May 5, 2008, CenterPoint filed an application with the Commission (Docket No. 35369) seeking approval of an AMS deployment plan and a surcharge to recover the costs of deployment pursuant to that plan.<sup>16</sup> CenterPoint's plan provided for the full deployment of advanced meters within five (5) years to over 2.4 million residential and non-residential retail electric customers in CenterPoint's service area.<sup>17</sup> CenterPoint's plan, as revised, was approved by the Commission on December 22, 2008.<sup>18</sup>

CenterPoint began deployment of advanced meters in March 2009.<sup>19</sup> As of May 2010, CenterPoint had deployed approximately 400,000 advanced meters.<sup>20</sup>

AEP Texas

On April 20, 2009, AEP Texas filed an application with the Commission (Docket No. 36928) seeking approval of an AMS deployment plan and a surcharge to recover the costs of deployment pursuant to that plan.<sup>21</sup> AEP Texas' plan provided for the full deployment of advanced meters by the end of 2013 to approximately 1.1 million residential and non-residential retail electric customers in AEP Texas' service area. AEP Texas' plan, as revised, was approved by the Commission on December 17, 2009.<sup>22</sup>

AEP Texas began deployment of advanced meters in November 2009.<sup>23</sup> As of May 2010, AEP Texas had deployed approximately 16,000 advanced meters.<sup>24</sup>

<sup>14</sup> Compliance Report of Oncor Electric Delivery Company LLC Pursuant to the Commission's Order Issued in Docket No. 35718 as of November 2008.

<sup>15</sup> Compliance Report of Oncor Electric Delivery Company LLC Pursuant to the Commission's Order Issued in Docket No. 35718 as of May 2010.

<sup>16</sup> Application of CenterPoint Energy Houston Electric, LLC for Approval of Deployment Plan and Request for Surcharge for an Advanced Metering System (Docket No. 35369).

<sup>17</sup> CenterPoint received a \$200 million ARRA grant from the U.S. Department of Energy in March 2010, which will allow it to complete installation of over two million advanced meters by 2012 rather than 2014.

<sup>18</sup> Order in relation to Application of CenterPoint Energy Houston Electric, LLC for Approval of Deployment Plan and Request for Surcharge for an Advanced Metering System (Docket No. 35369).

<sup>19</sup> Monthly Progress Report of CenterPoint Energy Houston Electric, LLC for Period Ending March 31, 2009.

<sup>20</sup> Monthly Progress Report of CenterPoint Energy Houston Electric, LLC for Period Ending May 31, 2009.

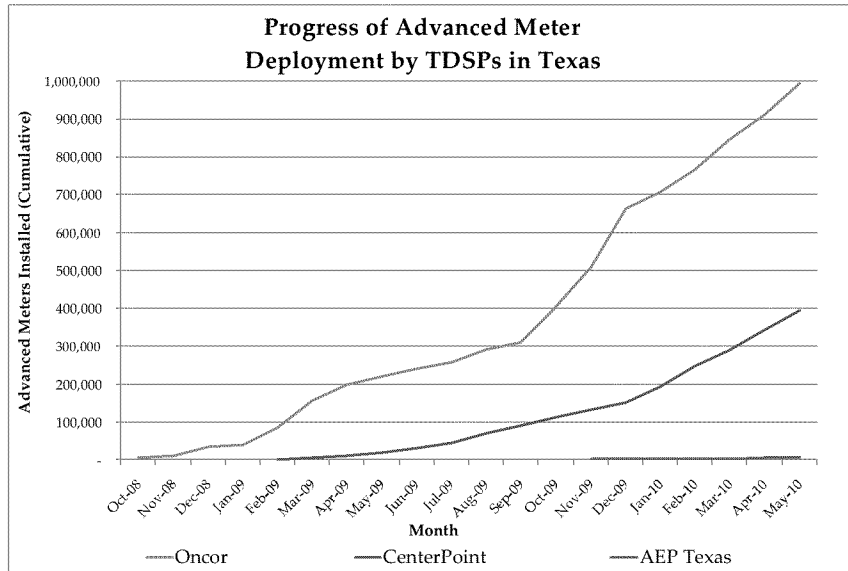
<sup>21</sup> AEP Texas Central Company's and AEP Texas North Company's Request for Approval of Advanced Metering System (AMS) Deployment Plan and Request for AMS Surcharges (Docket No. 36928).

<sup>22</sup> Order in relation to AEP Texas Central Company's and AEP Texas North Company's Request for Approval of Advanced Metering System (AMS) Deployment Plan and Request for AMS Surcharges (Docket No. 36928).

<sup>23</sup> Compliance Report of AEP Texas Central Company and AEP Texas North Company Pursuant to the Commission's Order Issued in Docket No. 36928 as of November 2009.

<sup>24</sup> Compliance Report of AEP Texas Central Company and AEP Texas North Company Pursuant to the Commission's Order Issued in Docket No. 36928 as of May 2010.

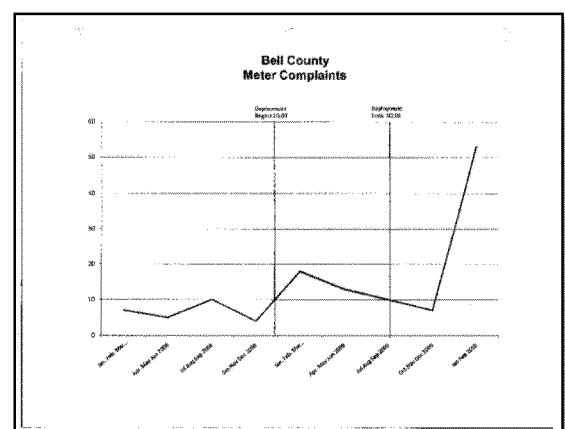
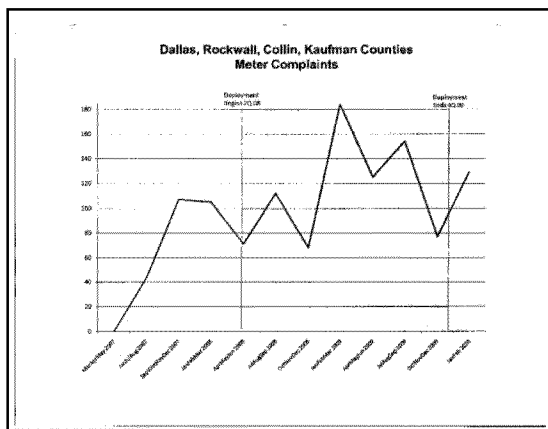
Total advanced meters deployed by Oncor, CenterPoint and AEP Texas of May 31, 2010 is summarized in *Figure 7* below:



C. Expressed Concerns by Customers, Texas Legislators, the Media, and Others

1. Increased Incidence of Customer Complaints – “Higher Electric Bills”

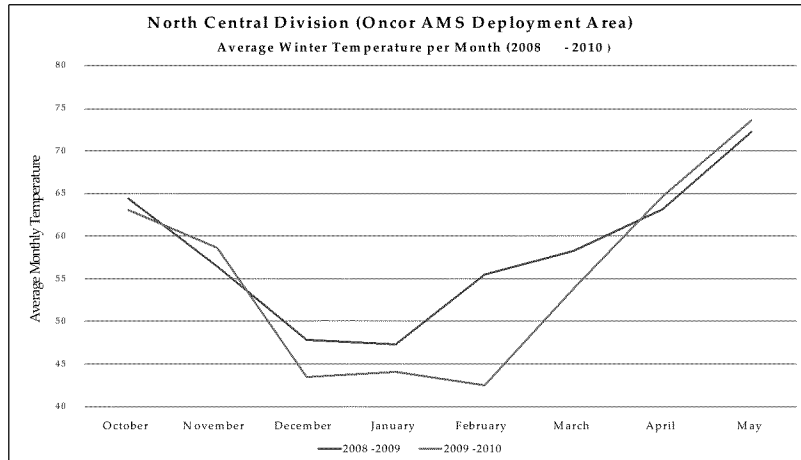
Beginning in early 2010, the Commission, as well as others, noted an increase in customer complaints regarding their electric bills. Much of the media and public attention focused on customers claiming a possible connection between higher electric bills and new advanced meters being deployed across Texas. At the time, both Oncor and CenterPoint were rapidly deploying advanced meters across their respective service areas.<sup>25</sup> The following graphs by Commission staff summarize their preliminary observations as to the increase in Complaints:



<sup>25</sup> At the beginning of 2010, AEP Texas had yet to initiate deployment of advanced meters other than a few thousand meters pursuant to a pilot program.

While it is not uncommon for certain customers to experience higher electric bills (as well as register complaints) in the colder winter months, the significant increase in complaints in early 2010 raised concerns among customers, consumer interest groups and the media, as well as various Texas legislators and the Commission.

Initially, much of the concern related to customer , high bills' was attributed to the unseasonably cold winter. Customers in both Oncor and CenterPoint service areas, as well as across Texas, experienced one of the coldest winters of recent history. *Figure 8* compares temperatures in part of Oncor's service area over the past two winters.



As is typical in winter, customers with electric heat tend to see a significant increase in their bills resulting from the use of electricity to heat their homes. On the other hand, customers that use primarily natural gas for heating tend to see increases in their gas bills instead. The 2009 / 2010 winter was characterized not only by the frigid temperatures across the state, but also by the duration (i.e., days) of those lower temperatures.

Many customers, as well as others, however, continued to question their observed higher electric bills and concerns persisted with regard to whether the deployment of advanced meters contributed to the observed increase in electric bills during this period.

## 2. Class Action Lawsuit (Oncor)

The concerns also prompted a group of individuals to seek redress through the courts in the filing of a class-action lawsuit. On May 16, 2010, Robert and Jennifer Cordts, individually and on behalf of a putative class of persons and/or entities similarly situated (the , Plaintiffs' ), filed a lawsuit in Dallas County District Court (seeking class action status) against Oncor. The lawsuit alleges various causes of action against Oncor regarding the deployment and accuracy of advanced meters.<sup>26</sup>

### D. Retention of Navigant Consulting

Continued questions regarding the potential link between higher electric bills observed by some customers and the deployment of advanced meters culminated in a decision by the Commission to retain an independent third party to evaluate the accuracy of the advanced meters being deployed, as well as other potential causes for the observed incidence of higher electric bills.

<sup>26</sup> Plaintiff's Original Petition – Robert Cordts and Jennifer Cordts, individually and on behalf of persons and/or entities similarly situated vs. Oncor Electric Delivery Company, LLC, Cause No. 10-03504.



**III. Scope and Objectives of the Investigation**

In an effort to address the concerns raised, as well as restore credibility in the advanced metering systems being deployed in Texas, the Commission, in conjunction with Oncor, CenterPoint and AEP Texas, retained Navigant Consulting to provide independent and objective analysis, investigation and evaluation of advanced meters and metering systems being deployed in Texas.<sup>27</sup> Navigant Consulting entered into separate, but similar, engagement letters with the Commission and each of Oncor, CenterPoint and AEP Texas.

**A. Agreed Scope of Work**

Pursuant to the terms of Navigant Consulting’s retention, Navigant Consulting worked with Oncor, CenterPoint and AEP Texas to provide the independent professional services described below. As the regulatory authority for Oncor, CenterPoint and AEP Texas, the Commission provided oversight and direction to the independent evaluation and investigation. More specifically, Navigant Consulting’s scope of work encompassed the following:

- Meeting with the TDSPs and the Commission to gain an understanding of the issues to be addressed and proposed coordination of efforts including identifying and reviewing information regarding the TDSPs’ residential advanced meter deployment and advanced meter infrastructure, as well as applicable processes, written procedures and controls.
- Analysis of residential customer complaints to the Commission and the TDSPs with regard to residential advanced meters deployed across the TDSPs’ service areas including evaluation of identifiable trends, patterns and/or inconsistencies, as well as comparison to complaints with regard to traditional/conventional meters (i.e., electromechanical meters).
- Analysis of a statistically significant sample of residential customer billing and power use history for customers with advanced meters, as well as a sample of residential customers that have yet to receive advanced meters, and identification and evaluation of unexpected variances, anomalies and/or inconsistencies.
- Monitoring and evaluation of residential advanced meter testing procedures employed by the TDSPs at various stages during their advanced metering system deployment including prior to residential advanced meter installation, in response to residential customer complaints, and proposed additional advanced meter testing.
- Providing oversight and monitoring of testing of a statistically significant sample of residential advanced meters by an independent third-party testing service, including potential side-by-side testing of residential advanced meters with non-advanced meters, and comparison of results to prior, as well as ongoing, testing by the TDSPs.

<sup>27</sup> Pursuant to that process, both Oncor and CenterPoint submitted proposed plans to evaluate the accuracy of the advanced meters being deployed and their respective advanced metering systems.

**B. Public Utility Commission Oversight**

The Commission provided oversight and direction of the independent investigation and evaluation conducted by Navigant Consulting. In addition to ensuring that a thorough and complete investigation was conducted, the Commission provided assurance that Navigant Consulting’s efforts, and the resulting report, were not subject to any improper influence by the TDSPs, or other outside parties. Throughout the investigative process, a representative from the Commission has been integrally involved in monitoring, evaluating, and providing significant input into the work steps performed by Navigant Consulting.

**C. Objectives of the Investigation**

Navigant Consulting undertook this assignment with the understanding that the Commission, Oncor, CenterPoint and AEP Texas all have a vested interest in the successful deployment and customer transition to advanced meters and the underlying advanced metering systems, as well as in maintaining confidence in the system in the early stages of the deployment to increase the probability of long-term success. Early success is believed to be critical for the next phases of AMS deployment, which will involve even greater customer involvement as more advanced functionality like Home Area Networking (HAN) and Remote System Operations are applied to this foundation of the AMS infrastructure.

The primary objective of Navigant Consulting’s efforts has been to investigate and evaluate matters within the broad scope of the engagement, while maintaining independence in the process. As initially agreed to with the Commission and the respective TDSPs, Navigant Consulting’s task has been to conduct an independent investigation and evaluation into the questions and concerns raised regarding the advanced metering system deployment by the respective TDSPs. More specifically, Navigant Consulting’s efforts focused on addressing the following questions:

1. Is electricity usage accurately measured and recorded by the TDSP?

The first question sought to address whether the advanced meters were accurately recording a customer’s electricity usage within an acceptable range of accuracy. Navigant Consulting’s efforts included: 1) conducting independent meter accuracy testing; 2) evaluating each TDSP’s internal meter testing processes, deployment procedures and controls; and 3) analysis of each TDSP’s historical meter test results.

2. Is electricity usage accurately communicated to the REP?

The second question sought to address whether electricity usage information recorded by a customer’s advanced meter was accurately communicated from the meter through the various TDSP communication and information systems and ultimately to the customer’s REP for use in billing the customer.<sup>28</sup> Navigant Consulting’s efforts included: A) a detailed review of each TDSP’s

<sup>28</sup> It is important to note that in the ERCOT retail electric market, the TDSP provides usage information (in kWh) to ERCOT, who in turn makes it available to the applicable REP. The REP then applies its own pricing structure to this usage information to determine the amount to be billed to the customer.

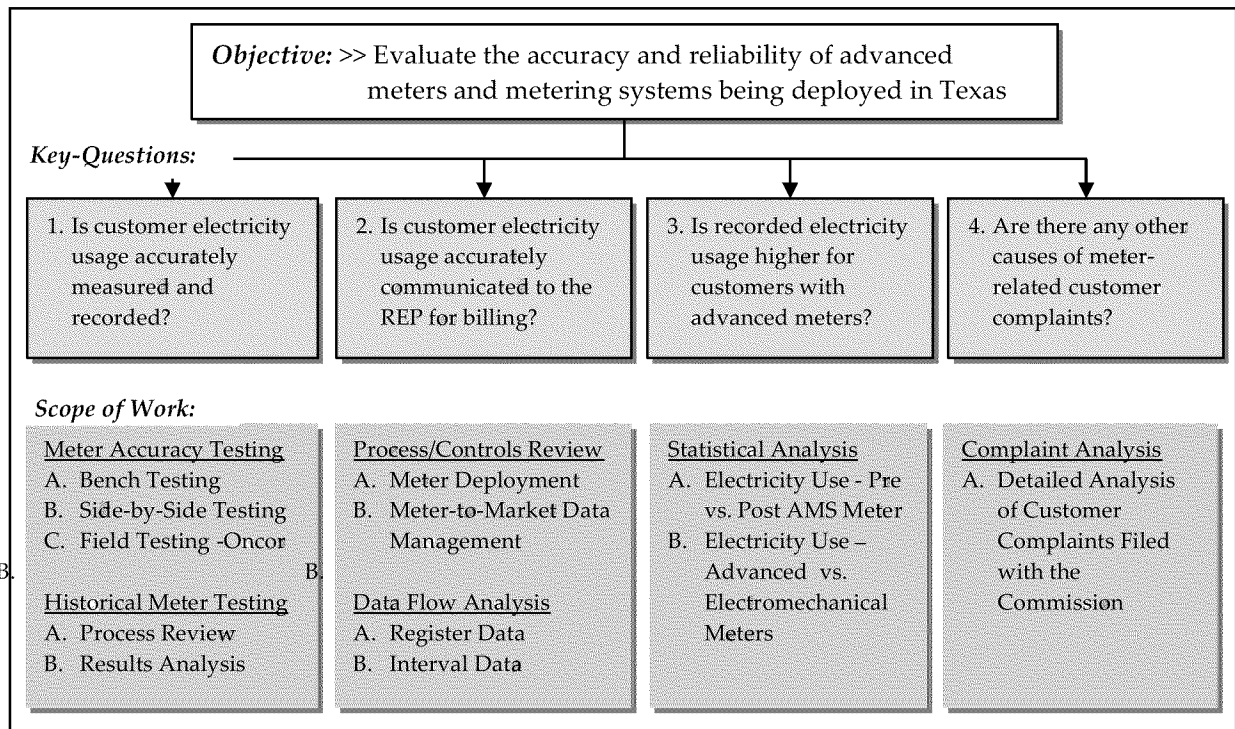
meter deployment and ,meter-to-bill' data management processes and controls; and B) a ,meter-to-bill' data flow analysis where information from the advanced meters was traced through the various points in the TDSP's information systems.

3. Is recorded electricity usage higher for customers with advanced meters?

In addition to performing independent tests of the accuracy of the advanced meters, as well as the effective and accurate communication of the electric usage from the advanced meter through to a customer's bill, Navigant Consulting also sought to analyze whether customers with advanced meters had experienced either more electric usage or higher bills on average than customers with older electromechanical meters. Navigant Consulting's efforts included: A) performing a statistical comparison of electric usage trends before and after installation of advanced meters; and B) a statistical comparison of customers with advanced meters versus customers with older electromechanical meters.

4. Are there other causes of meter-related customer complaints?

While the questions outlined above address specific areas and potential causes of the observed increase in customer higher electric bills and complaints, Navigant Consulting also sought to determine, through a detailed analysis of customer complaints filed with the Commission, if any additional causes for customer concerns exist. Navigant Consulting's efforts are summarized in *Figure 9 Key Questions and Scope of Work in AMS Deployment Evaluation* below.



Given the breadth of the defined scope of work, Navigant Consulting approached the engagement with the objective of striking an appropriate balance between obtaining adequate information to

reach an informed conclusion and avoiding the imposition of excessive burden, an unacceptable time frame, and undue expense upon the TDSPs. However, it was understood by all parties that if issues or potential problems were identified, Navigant Consulting would expand its work plan in an appropriate manner to address those areas.

**D. Summary of Work Performed**

Navigant Consulting’s role was to apply financial, accounting and electric utility industry expertise and independence to the design and execution of an investigation of the allegations and an evaluation of the underlying advanced metering systems and infrastructure at the TDSPs.

1. Overview of Work Steps

As with many engagements Navigant Consulting undertakes, relevant information for our investigation and analysis was gathered from a variety of sources. While each engagement has unique characteristics, the evaluative process applied in this matter contained elements similar to those utilized by Navigant Consulting in other matters. These steps included:

- Meeting with relevant parties to gain an initial understanding of issues to be addressed and proposed coordination of our efforts;
- Identifying and reviewing relevant information to gain understanding of the respective TDSPs’ businesses, organizations and advanced metering systems (AMS), as well as the general trend toward ‘Smart Meters’ and the ‘Smart Grid’ in the electric utility industry;
- Identifying relevant electronic records, including customer billing and historical meter accuracy testing information, and extracting and reviewing necessary information;
- Reviewing and evaluating TDSP policies, processes and written procedures, and other management practices in relation to its deployment of advanced meters, as well as operation of its AMS;
- Interviewing individuals with information relevant to the areas being evaluated and investigated and identifying additional areas for review;
- Developing an understanding of the processes followed regarding customer inquiries and complaints and efforts by the Commission and the TDSPs to address those concerns;
- Evaluating business practices and process flows associated with certain functional areas of each TDSPs’ AMI including the processes surrounding the recording, storing, transmitting and validation of data from a customer’s advanced meter to the TDSPs back-end customer information system, and ultimately to the REPs who utilize the information in preparing customer bills.
- Reviewing and evaluating issues, challenges and potential problems that have been addressed to date by the respective TDSPs during their deployment of advanced meters and development of their respective advanced metering systems including issues that may have resulted in either meter change-outs, firmware changes or customer re-bills;

- Evaluating information obtained during the course of our work for evidence of inaccurate meters, inaccurate customer billing, problems in the advanced metering systems that may have had, could have, an impact on customer billing; and
- Integrating information learned from identified documentation, interviews and analyses, and summarizing our observations, findings, and recommendations.

2. Document and Electronic Information Review and Analysis

During the course of the four-month long investigation and evaluation, Navigant Consulting independently tested over 5,100 advanced meters for accuracy and reviewed historical test results for accuracy on close to 1.1 million advanced meters and over 86,000 electromechanical meters.

At our request, we were provided with over 18,000 pages of hard copy documents and files, including information provided by the Commission, as well as documents provided from various departments within the TDSPs responsible for certain aspects of the TDSPs advanced meter deployment and provisioning, meter data management and customer information systems. In addition, Navigant Consulting had full access to electronic records available from each TDSP including records related to all advanced meters deployed and the historical electric usage for customers with advanced meters. We identified and reviewed approximately 345 million records and 40 Gigabytes (GB) of potentially relevant electronic files.

3. Interviews of Key Personnel

Throughout the course of the investigation, we attempted to interview all those individuals who, to our knowledge, were likely to have significant information relevant to our evaluation and investigation. To that end, Navigant Consulting had access to over 60 individuals at the respective TDSPs regarding the applicable advanced meter deployment and provisioning, as well as the business processes and controls surrounding the TDSPs advanced metering infrastructure.

**E. Independence, Integrity and Objectivity**

At all times during the investigation, Navigant Consulting has remained independent of the respective TDSPs, the Commission, and other parties expressing questions or concerns over the advanced metering system deployment in Texas. Prior to accepting the engagement, Navigant Consulting performed a check based on the names of the parties involved in this matter and we identified no circumstances or prior material relationships with the TDSPs or current or former management or the Board that constituted a conflict of interest or that could have impaired our ability to provide objective assistance.

Throughout the course of the investigation, Navigant Consulting was engaged with the Commission, who supervised and directed the scope of the investigation. However, notwithstanding the input provided by the Commission, they placed no restrictions on the scope of the investigation and Navigant Consulting has exercised its professional judgment regarding the scope, timing and nature of our work.

**F. Confidentiality of Customer Information and Critical Infrastructure**

Navigant Consulting’s efforts included the identification, preservation, and recovery of potentially confidential and sensitive information in the form of both hard-copy and electronic records from the TDSPs, as well as of the Commission, including electronic data, files and information covering current and historical customer billing information, as well as current and historical customer complaints. In addition, we have had access to significant technical and potentially propriety information regarding the advanced metering systems and infrastructure employed and in use by the TDSPs. At all times, Navigant Consulting has maintained the confidentiality of this information and exercised reasonable care to ensure that this information was not inadvertently disclosed to parties outside of the engagement.

**G. Limitations**

Certain practical limitations existed as to the information available during the engagement. Although Oncor, CenterPoint and AEP Texas employees have been very cooperative with our requests for information, we had no power to compel third parties, including outside consultants, suppliers or REPs providing service in the TDSP service territories to submit to interviews, produce documents, or otherwise provide information. From the initial analysis, the team recognized that there may not be a simple explanation for the increase in complaints and questions of advanced meter accuracy. The large geographic and demographic areas for this evaluation in addition to the inherent complexity of the advanced metering systems and technology employed by the TDSPs would require an exhaustive approach to address all of the questions and concerns of interested parties and, as such, Navigant Consulting has focused on those questions most critical to stakeholders.

Within these inherent limitations, we believe that our investigation and evaluation was extensive, careful, independent and impartial, and that the facts developed afford a reasonable foundation upon which to base the observations, findings and recommendations set out in this Report. The remainder of this Report discusses the detailed results of Navigant Consulting’s investigation, analysis and evaluation of advanced metering systems deployed in Texas by each of the three (3) TDSPs.

## IV. Overview of Electric Utility Industry and the "Smart Grid"

### A. Electric Utility Industry

The U.S. electric power system generates, transforms, transports, and distributes electrical energy to consumers. It is an industry comprised of a collection of investor-owned, cooperative, municipal, state and federal utilities that serve over 143 million residential, commercial and industrial customers across the U.S.<sup>29</sup> The vast majority of electric customers are residential (87%), yet residential customers account for only a third (35%) of the total electricity consumed.<sup>30</sup>

The electric power system in Texas is comprised of primarily three (3) types of companies: power generation companies, transmission and distribution companies, and REPs.

- **Power Generation Companies** – own and operate power plants, including plants fueled by coal, nuclear power, natural gas, wind and other renewable sources. Power generation companies sell this power at wholesale to REPs, who package the power with transmission and delivery service for sale to retail customers.
- **Transmission and Distribution Companies** – provide the actual delivery of electricity over poles and wires to a customer's home or business. Local TDSPs are responsible for maintaining the poles, wires, substations, transformers and electric meters, as well as responding to power outages and other concerns regarding electricity use. The Commission regulates TDSPs to ensure the safety and reliability of electric service provided to customers.
- **Retail Electric Providers** – buy wholesale electricity from power generators, and delivery services from TDSPs, and then sell electricity at retail to customers, as well as handle the customer service and billing. REPs must be certified to do business by the Commission.

With responsibility for the , poles and wires, ' TDSPs like Oncor, CenterPoint and AEP Texas are at the forefront of efforts nationwide by the electric utility industry to move toward a more technologically advanced method of measuring, recording and tracking customer electric usage. Some of the first steps toward a Smart Grid (i.e., the deployment of advanced meters and metering systems and infrastructure) are within the control and management of the TDSPs.

#### 1. Upgrading America's Electric Power System (the , Smart Grid ')

It is widely believed that the U.S. electric power delivery infrastructure has served our nation well throughout the 20<sup>th</sup> century providing adequate, affordable energy to homes, businesses and factories. In fact today, the continued operation and consistency of electric energy supply is almost an afterthought to the everyday customer. However, some believe that the aging technology, infrastructure and compatibility amongst the various components of the electric power system could result in more frequent blackouts, greater vulnerability, and energy inefficiency. The need

<sup>29</sup> Energy Information Administration Electric Power 2008 Annual.

<sup>30</sup> Ibid.

for improvements, driven by advances in key technology areas, provides a vision of the future in what has become known as the 'Smart Grid'.

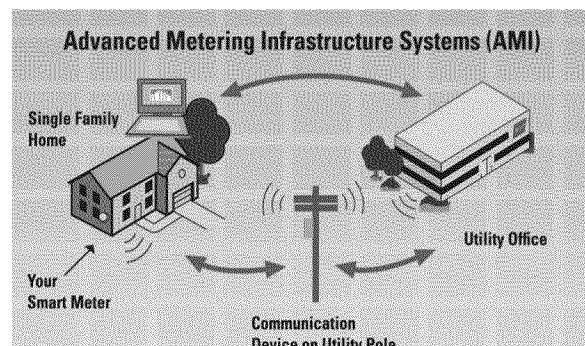
2. What is the Smart Grid?

Modernization of the electric power system, driven by advances in technology, is at the forefront of the Smart Grid. Loosely defined, the Smart Grid includes the digital automation of the entire power supply system from power generation to delivery to the customer for purposes of improving the *security, quality, reliability, efficiency and safety* of electric power, as well as be more *environmentally friendly*.

The objectives of the Smart Grid are generally defined by the following characteristics:<sup>31</sup>

- **Enable active participation by consumers** – by giving consumers more information, control and options regarding the electricity they use.
- **Accommodate all generation and storage options** – by seamlessly integrating all types and sizes of electrical generation and storage systems from large central power plants to environmentally friendly sources such as wind and solar farms.
- **Enable new products, services and markets** – including the creation of new electricity markets from home energy management systems to technologies that will allow consumers and third parties to bid their energy resources into the electricity market.
- **Provide power quality for the digital economy** – by monitoring, diagnosing and responding to power quality deficiencies resulting in a dramatic reduction in the business losses currently experienced by consumers due to insufficient power quality.
- **Optimize asset utilization and operate efficiently** – that will improve load factors, lower system losses, and dramatically improve outage management.
- **Anticipate and respond to system disturbances (self-heal)** – by performing continuous self-assessments to detect and analyze issues, and take corrective action to mitigate them.
- **Operate resiliently against attack and natural disaster** – by incorporating a system-wide solution to reduce physical and cyber vulnerabilities and enable rapid recovery.

Advanced Metering Infrastructure ('AMI') is one aspect of the Smart Grid currently being developed. AMI focuses primarily on a utility's customers by providing them with more information, control and options. At its core, AMI consists of advanced or 'smart' meters that monitor and communicate power flows and usage, controls that measure and monitor flows and usage, and data management systems that



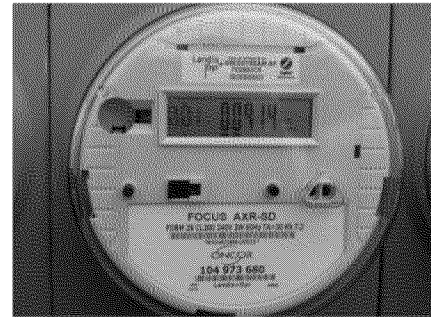
<sup>31</sup> What is the Smart Grid? Office of Electricity and Energy Reliability, U.S. Department of Energy.



store and process metering and control data. AMI has potential implications for most aspects of utility operations including potential financial benefits, cost reduction, improved service and compliance, and opportunities for more consideration of environmental concerns.

### 3. What is an Advanced (i.e., ,Smart') Meter?

Advanced meters, also commonly called ,smart meters', are the first step in moving the electric power system into the digital age. Smart meters are digital electronic metering devices that typically work just like a traditional electric meter – recording electric usage at a customer's home or business. However, advanced meters include a secure two-way communication feature that allows meter readings to be taken remotely and will eventually enable consumers to monitor and be more in control of their electric usage.



Smart meters are a key part of the envisioned Smart Grid with common features including:

- Two-way communications between the meter, or customer, and the electric provider;
- Recording of cumulative interval data on energy usage (e.g., every 15-minutes);
- Delivery of data to the utility at least daily;
- A service connect / disconnect switch; and
- Power quality sensing (voltage) and diagnostic health check.

The majority of electric meters still in use are electromechanical meters. However, while electromechanical meters adequately perform the service of recording electricity usage, they provide little other functionality. Advanced meters have been in development and use for many years, but were not in widespread use in the United States until a few years ago. Today, however, there is significant migration away from electromechanical meters to advanced meters with major deployments occurring throughout the developed world including in Canada, Japan, South Korea, Australia, New Zealand, and many parts of Europe. Advanced meters are expected to become the most prevalent type of meter in use during the next five (5) years.

With digital smart meters, consumers will be able to track their use of electricity in as small as 15-minute intervals via the internet or an in-home monitor. Smart meters also can be read remotely rather than requiring a meter reader to physically read a consumer's meter every month. They also will allow service to be connected and disconnected remotely, and for service interruptions (i.e., power outages) to be detected more quickly leading to faster restoration. It is also anticipated that smart meters will be able to interact with future smart appliances to allow consumers to manage thermostats and electric appliances remotely.

### 4. Advanced ( ,Smart') Metering Deployment and Trends

Advanced metering initiatives have been ongoing for many years and advanced meters are currently being introduced all over the developed world. It is estimated that approximately **80 million smart meters** are installed worldwide. At present, utilities and governments around the world are undertaking major efforts to deploy smart meters to their residential and commercial



no information on when or how a customer used electricity during that month, advanced meters can be read instantaneously and are expected to provide information in 15-minute intervals. This equates to almost 3,000 reads per month – versus the one read per month that most customers are used to.

Smart meters offer greater precision than standard electromechanical meters and can transmit consumer-usage data to utilities in near real time. Once the smart meters and advanced metering infrastructure are fully operational, consumers are expected to receive a number of potential benefits including:

- **Timely Access to Information** – customers will no longer have to wait for their monthly bill to know how much electricity they are using.
- **Expanded Product Options / Rate Plans** – the ability to track customer electricity usage per time of day will also enable utilities to offer flexible pricing schemes (e.g., cheaper rates at night) that in turn will enable customers to better manage their electricity usage.
- **Improved Service and Reliability** – better information and two-way communication with advanced meters will result in quicker restoration of electricity after outages.
- **Reduced Costs and Service Fees** – utilities may be able to reduce costs by reducing the need to buy high-priced peak power from generation companies, making new power plants unnecessary, and by lowering operating expenses.
- **Greater privacy** – utilities will no longer have to visit customer homes each month for the purpose of reading meters.
- **In-home monitors** – customers will be able to obtain devices that can provide immediate feedback from the smart meter, including their current and past electricity use.
- **Home Area Network** – over time, customers may also be able to remotely control 'smart' appliances in their home or business like a thermostat through the Internet.

Pursuant to its efforts to promote the development of the smart grid, the U.S. Energy Department in early 2010 pledged to invest up to \$100 million in educating consumers about the benefits and importance of the smart grid. In addition, the Obama administration has pledged \$3.4 billion toward 'smart grid' technology and to help speed smart grid development.

#### B. Texas Transmission and Distribution Service Providers (TDSPs)

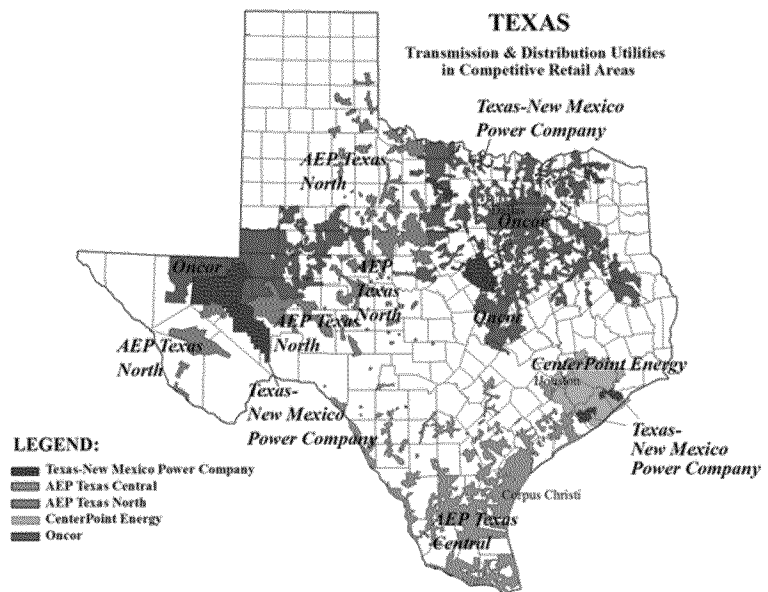
Oncor, CenterPoint and AEP Texas operate in Texas within the Electric Reliability Council of Texas ('ERCOT') region.<sup>35</sup> Combined these three (3) TDSPs serve approximately 6.9 million customers.

<sup>35</sup> ERCOT manages the flow of electric power to approximately 22 million Texas customers – representing 85 percent of the state's electric load and 75 percent of the Texas land area. As the Independent System Operator for the region, ERCOT schedules power on an electric grid that connects 40,000 miles of transmission lines and more than 550 generation units.

ERCOT is responsible for ensuring the reliable power operations for the wholesale and retail competitive markets in Texas' main electric power grid, and has provided the platform for Texas' transition to state-legislated retail competition.<sup>36</sup>

Pursuant to electricity market deregulation and the start of retail competition in Texas on January 1, 2002, formerly integrated electric utilities in Texas were required to separate their business functions into three (3) distinct entities: power generation companies, transmission and distribution utilities, and REPs.<sup>37</sup> TDSPs such as Oncor, CenterPoint and AEP Texas own, operate, and maintain the electrical network infrastructure that transmits or distributes electricity to consumers in their service territories. However, customers actually receive their bills from REPs. The regions served by each TDSP are highlighted in *Figure 10*.

Regardless of which REP a customer receives its bill from, the actual delivery of the electricity is provided by the TDSP in that area. TDSPs are responsible for maintaining the poles and wires that facilitate delivery of electricity, as well as the electric meters that measure the electricity consumed by the customer. TDSPs are also responsible for reading the electric usage recorded on the meter and providing the usage to ERCOT and the REP.



While the choice of REP does not affect the reliability of the transmission and distribution service, the choice of REP can affect how much a customer is paying for his or her electricity. REPs can compete for business by offering a variety of different pricing options, renewable energy options, added customer service benefits, or other incentives. Prices for electric usage are set and charged to customers by the REPs.

<sup>36</sup> ERCOT Organizational Profile, [www.ercot.com](http://www.ercot.com)

<sup>37</sup> Not all areas of the state are open to competition. Retail competition has been delayed for customers of Entergy Gulf States, Southwestern Public Service Company, El Paso Electric Company, and AEP SWEPCO by the Texas Legislature or the Commission because the necessary conditions for successful retail competition do not exist in these areas. Electric cooperatives and city-owned utilities may decide whether their customers will have a choice of REPs.

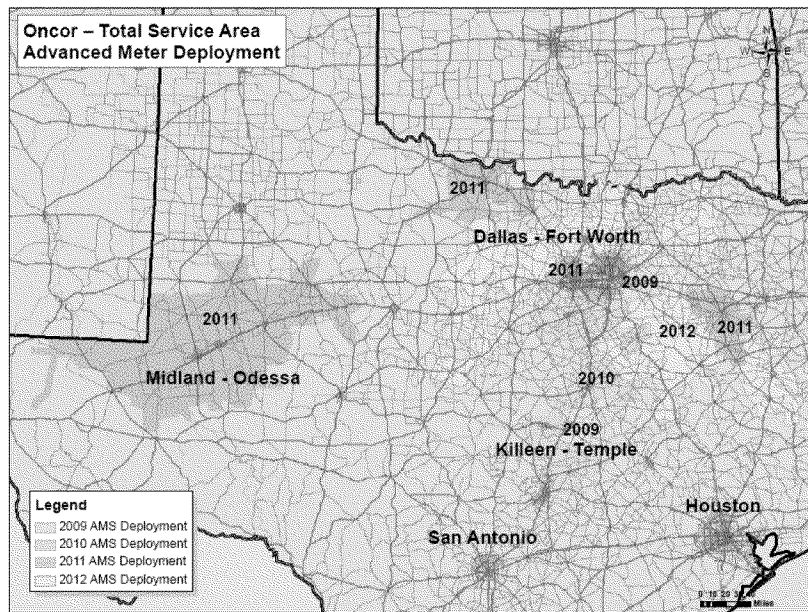
1. Oncor Electric Delivery Company, LLC

a) Overview

Oncor operates the largest distribution and transmission system in Texas, providing power to 3.4 million electric delivery points over more than 120,000 miles of distribution and 14,000 miles of transmission lines. Oncor supplies electricity to approximately seven million consumers, about one third of the state's population. Oncor operates in a service area in East, West and North Central Texas with 401 incorporated municipalities and 91 counties, and serves cities that include the Dallas-Fort Worth and surrounding area, Odessa, Midland, Killeen, Waco, Wichita Falls and Tyler.

b) Advanced Metering System Deployment

Oncor is currently deploying advanced meters that collect time differentiated energy usage data at 15-minute intervals to its residential and commercial customers throughout its service area. Oncor has already installed approximately one million advanced meters and is expected to complete installation of approximately 3.4 million advanced meters by the end of 2012.



Oncor's AMS also includes the construction of a highly secure infrastructure to enable two-way communication to REP-initiated pricing and Demand Response data to smart meters. Oncor is currently recovering the costs of deploying smart meters through a monthly service charge of \$2.19 per account, which is assessed on the residential customers of each REP. This charge is passed onto each customer. Oncor's system of integrated 'smart' technologies, including advanced meters and associated communications infrastructure and back-office computer systems is called *Smart Texas*.

2. CenterPoint Energy, Inc

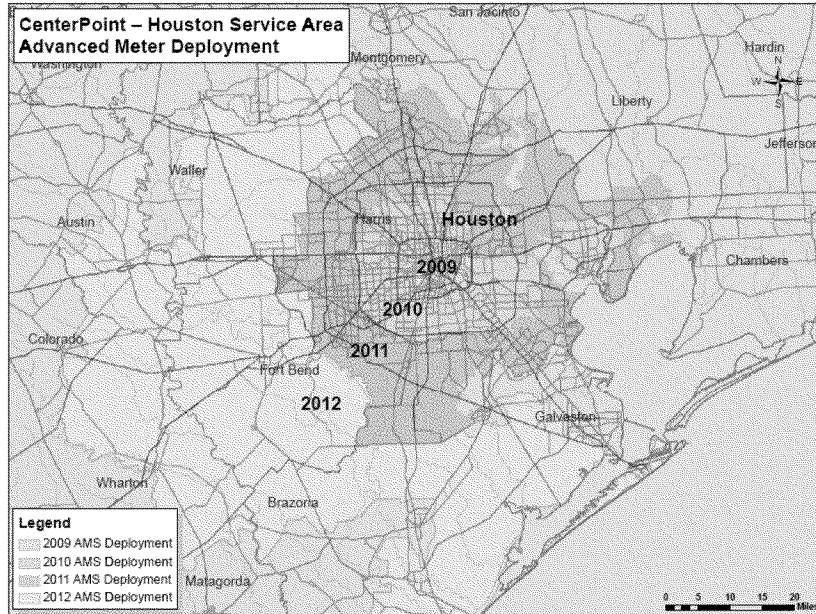
a) Overview

CenterPoint operates in five (5) primary businesses: electric transmission and distribution, natural gas distribution, interstate natural gas pipelines, field services, and competitive natural gas sales and services. In its transmission and distribution business, CenterPoint maintains wires, poles and electric infrastructure serving a 5,000 square-mile electric service territory in nearly all of the

Houston/Galveston metropolitan areas. With over 3,700 miles of transmission lines and 47,000 miles of distribution lines, CenterPoint delivers electricity to approximately 80 REPs, which sell electricity to over two million metered customers in CenterPoint's service area.

b) Advanced Metering System Deployment

CenterPoint is currently deploying an advanced metering system throughout its service area. CenterPoint began installing advanced meters in February 2009, with nearly 150,000 meters installed that year.<sup>38</sup> CenterPoint plans to complete installation of more than two million smart meters across the greater Houston area by mid 2012. Deployment began in central Houston and is moving outward.

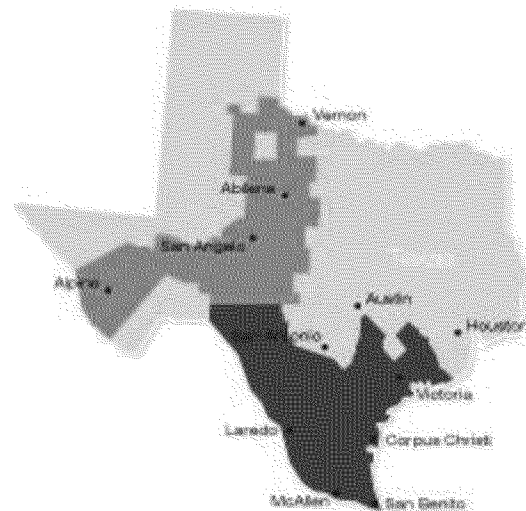


CenterPoint is currently recovering the costs of deploying the advanced meters through a monthly service charge of \$3.05 per month, which was \$3.25 during the first two (2) years. CenterPoint's system of integrated 'smart' technologies, including advanced meters is called *Energy Insight*.

3. AEP North Texas Company and AEP Central Texas Company

a) Overview

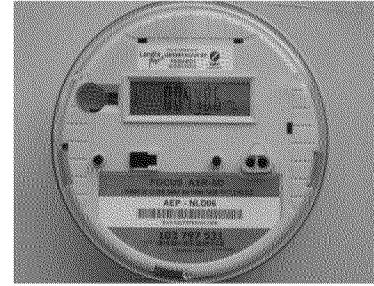
AEP Texas is part of the American Electric Power system, one of the largest electric utilities in the United States, and is comprised of two (2) electric utility operating companies - AEP Texas Central Company and AEP Texas North Company. AEP Texas serves more than one million electric consumers and delivers electricity to homes, businesses and industry across its nearly 100,000 square mile service territory. Headquartered in Corpus Christi, AEP Texas serves the major cities of Abilene, Corpus Christi, Harlingen, Laredo, McAllen, San Angelo, Vernon and Victoria.



<sup>38</sup> CenterPoint conducted a pilot program of advanced meter deployment between 2006 and 2008.

b) Advanced Metering System Deployment

AEP Texas' Advanced Metering Infrastructure system is aimed at moving AEP's existing electric grid into the digital age. AEP Texas began installing advanced meters to its 1.1 million customers in November 2009. AEP Texas expects to complete its deployment of advanced meters to its residential and commercial customers by 2013. AEP Texas is currently recovering the costs of deploying the advanced meters through a monthly service charge of \$3.15 per month from January 2010 to December 2011, \$2.89 per month for the following two (2) years, and \$2.26 per month from then until December 2020. AEP Texas' integrated system of advanced meters, associated communications infrastructure and back-office computer systems is called *gridSMART<sup>sm</sup>*.



4. SmartMeterTexas.com

In February 2010, Texas became the first market in the United States to initiate a single common repository and portal (or 'smart meter data exchange') to all retail electric customers in Texas to view daily electricity usage in 15-minute increments. It is anticipated that customers will use the information offered through 'Smart Meter Texas' to better understand their usage patterns and possibly reduce their electricity usage and costs.

Oncor, CenterPoint and AEP Texas are jointly sponsoring 'Smart Meter Texas', from which advanced meter usage data and meter functions will be available to consumers and authorized parties. Participating TDSPs will submit actual usage data to the common repository for use by electric customers, as well as their REPs to use in providing future retail offerings including energy analysis tools, time-of-use rates, pre-paid service, and other potential services to help customers better manage their electricity use.

## V. Accuracy Testing of Advanced Meters

### A. Background

The electric meter is a critical part of the electric utility infrastructure and an important element in measuring and recording the amount of electricity used by customers. The Commission requires electricity consumed by electric customers be measured and charged based on consumption reported by electric meters. Utilities are also required to purchase, install and maintain the electric meters provided to their customers, unless otherwise authorized.<sup>39</sup>

A central focus of Navigant Consulting's investigation and analysis was in relation to concerns regarding the accuracy of advanced meters and concerns regarding whether advanced meters were accurately recording customer electricity usage, as well as accurately and effectively communicating that usage from the meter to the electric utility for use in customer billing.

### B. Project Scope and Timeline

As previously described, the Commission engaged Navigant Consulting to conduct independent testing of the accuracy of a sample of advanced meters in use by Oncor, CenterPoint and AEP Texas. The purpose of the residential advanced meter testing was to determine the level of kilowatt hour (kWh) measurement accuracy of the tested advanced meters. Meter accuracy tests were performed on the following groups of meters:

- Bench Testing of ,New ' Advanced Meters – Accuracy testing of a sample of ,New ' advanced meters received from the manufacturer, but not yet placed into service.
- Bench Testing of ,Deployed ' Advanced Meters – Accuracy testing of a sample of ,Deployed ' meters in use by customers that were removed from service and tested.
- Field Testing of Advanced Meters – Accuracy testing of a sample of advanced meters in use Oncor's service territory that were tested on-site at the customer location or premise.
- Side-by-Side Testing of Advanced and Electromechanical Meters – Comparison of kilowatt hours (kWh) measured by a sample of advanced and electromechanical meters subjected to testing under the same load and environmental conditions.

In addition to performing independent accuracy tests on the samples of advanced meters described above, Navigant Consulting also requested and reviewed the results of various accuracy tests performed on advanced meters by the meter manufacturers, as well as the respective TDSPs.

### C. Advanced Meter Technology Deployed

The independent meter accuracy testing was performed on Class 200, Form 2S, single phase, three wire residential advanced meter types in use by the respective TDSPs, which are described below:

<sup>39</sup> Commission Substantive Rules on Advanced Metering §25.130.



- Oncor – Landis+Gyr Focus AXR and AXR-SD advanced meters with Gridstream communication modules.
- CenterPoint – Itron Centron advanced meters with OpenWay communication modules.
- AEP Texas – Landis+Gyr Focus AXR-SD advanced meters with Gridstream communication modules.

#### D. Applicable Standards and Meter Accuracy Requirements

##### 1. Public Utility Commission of Texas

The Commission has established various requirements applicable to electric meters, which are promulgated in the Commission’s substantive rules on metering (Texas Administrative Code, Title 16, Part II, Chapter 25 – Substantive Rules Applicable to Electric Service Providers, Subchapter F – Metering.) The Commission’s rules include requirements regarding the accuracy of meters stating:

*No meter that violates the test calibration limits as set by the American National Standards Institute, Incorporated, shall be placed in service or left in service; [and] < Meters shall be adjusted as closely as practicable to the condition of zero error.*

In summary, the Commission requires that no meter can be placed in service , unless its accuracy has been established’ and that meter testing , shall conform to the latest edition of American National Standards Institute, Incorporated (ANSI) Standard C12’ unless otherwise specified.

##### 2. American National Standards Institute ( , ANSI’)

ANSI standards are widely referenced as the standards for acceptable performance for electric meters and metering devices.<sup>40</sup> ANSI has established , acceptable performance criteria for new types of ac [alternating current] watthour meters, demand meters, demand registers, pulse devices, and auxiliary devices’ and , describes acceptable in-service performance levels for meters and devices used in revenue metering. <sup>41</sup>

Pursuant to ANSI standards, meters are subjected to a battery of tests before being approved and accepted for use by residential and commercial customers. The various testing requirements are specifically described in the applicable standards including the required test conditions. ANSI C12.1 forms ,the basic requirement for all kilowatt hour measuring devices – both electronic and electromechanical’ including providing the minimum acceptable performance standards for all watt-hour meters. ANSI C12.1 states:<sup>42</sup>

*The performance of all watt-hour meters is considered to be acceptable when the percent registration is **not less than 98% or more than 102%...**” [Emphasis added]*

<sup>40</sup> The American National Standards Institute oversees the creation, promulgation and use of thousands of norms and guidelines that impact businesses in every sector of the economy.

<sup>41</sup> American National Standard for Electric Meters, ANSI C12.1-2008, Code for Electricity Metering.

<sup>42</sup> ANSI C12.1-2008, §5 Standards for in-service performance.

While the same minimum acceptable performance criteria applies to both electromechanical and advanced meters, advanced meters are designed to perform at a higher degree of accuracy. Advanced meters are typically classified as either 0.2 or 0.5 accuracy class meters meaning that they are expected to perform (i.e., be accurate) within either plus/minus 0.2% or 0.5%.

ANSI C12.20 (*For Electricity Meters – 0.2 and 0.5 Accuracy Classes*) addresses solid state (i.e., advanced) meters with higher degrees of accuracy and generally , provides different test tolerances and a few different tests that are required for higher accuracy metering devices.<sup>43</sup> However, ANSI C12.20 specifically addresses polyphase meters (not single phase residential meters, the types being used by Oncor, CenterPoint and AEP Texas). Nonetheless, ANSI C12.20 provides guidance on the expected minimum performance standards of 0.2 and 0.5 accuracy class meters.

Oncor, CenterPoint and AEP Texas expect their advanced residential meters to perform to a higher degree of accuracy than the 98% to 102% standard defined above, and have established internal accuracy performance standards of within plus/minus 0.5% (i.e., 99.5% to 100.5%) – which is a benchmark also applied by Navigant Consulting in our analysis.

### 3. National Institute of Standards and Technology (, NIST')

In addition to the applicable ANSI standards for electric meter performance, standards also exist for the testing equipment utilized to evaluate electric meter performance and accuracy. Test equipment used to test electric meters are required to maintain standards whose calibration values are traceable to national standards established by NIST, a function of the U.S. Department of Commerce. Each utility (and testing laboratory or facility) , has the responsibility to establish and maintain the traceability of the watt-hour standard to the national standard either directly or indirectly.<sup>44</sup>

## E. Work Performed

Navigant Consulting conducted independent testing of the accuracy of advanced meters in use by the TDSPs, as well as a review of the historical testing procedures and results provided by the meter manufacturers and TDSPs. Observations regarding the historical testing procedures and testing results of the meter manufacturers and TDSPs are discussed in Section VI of this Report.

### 1. Accuracy Performance Check

Pursuant to Commission requirements and applicable ANSI standards, advanced meters in use by Oncor, CenterPoint and AEP Texas were independently tested for accuracy consistent with the Accuracy Performance Check as defined in ANSI C12.1, which states, in part:

*A test device shall be designated as failed if...\*t]he metering devices fails to remain within accuracy limits...as the result of the Accuracy Performance Check...<sup>45</sup>*

<sup>43</sup> ANSI C12.1-2008, Forward.

<sup>44</sup> ANSI C12.1-2008, §3 Standards and standardizing equipment.

<sup>45</sup> ANSI C12.1-2008, §4.6.2 Determination of Failure and Rejection.

The Accuracy Performance Check includes the following: , verify the manufacturer stated accuracy at Full Load, Light Load, and Power Factor <sup>46</sup> where , Full Load' is defined as 100% of test amperes (i.e., 30 amps) at unity power factor and , Light Load' is 10% of test amperes (i.e., 3 amps) at unity power factor and , Power Factor' 100% test amperes with 50% lagging power factor.<sup>47</sup>

2. Independent Testing of Advanced Meters

The advanced meters tested and sample sizes for each TDSP are summarized in *Figure 11* below:

Test Period		Independent Evaluation of AMS Deployment in Texas				
Responsibility		Navigant Consulting /LuthanElectric Meter Testing			Navigant Consulting / Met Labs	
Meter Type		Advanced			Advanced	Non--Advanced
Test Location		Bench Test - Lab / Meter Shop		Field Test	Side-by-Side Test- Lab / Meter Shop	
Meter Type - New / Deployed		New	Deployed	Deployed	Deployed	
Sample Selection		Random Sample-- Meters in Inventory	Random Sample-- Meters in Service	Customer Requested	Random Sample-- Advanced and Electromechanical Meters	
Test Type		Accuracy Performance Check	Accuracy Performance Check	Accuracy Performance Check	Comparison of kWhRegistration under Specific Load and Temp.	
Description		Test Meters Selected from Inventory	Test Meters Removed from Service	Test Meters Currently in Service	Compare Performance of 50 Paired AMS and Electromechanical Meters	
Oncor	Sample Size	1,152	1,042	521	25	25
CenterPoint	Sample Size	1,152	1,075	n/a	25	25
AEP	Sample Size	96	96	n/a	25	25
Total	Sample Size	2,400	2,213	521	75	75
<i>Notes</i>		1. The standard Accuracy Performance Check includes accuracy tests for Full Load, Light Load and Power Factor.				

The accuracy testing of advanced meters was conducted by independent third-party meter testing services companies under the direction of Navigant Consulting. Luthan Electric Meter Testing, LLC (Luthan) was selected to provide independent testing services in relation to the , New ' and , Deployed ' advanced meters, as well as the in-service testing of advanced meters in the Oncor service area.<sup>48</sup> MET Laboratories, Inc. ( , MET Labs ' ) was selected to conduct the side-by-side comparison tests of advanced and electromechanical meters.<sup>49</sup> Both Luthan and MET Labs were selected through an RFP process and demonstrated the required capability and experience.

<sup>46</sup> ANSI C12.1-2008, §4.7.3 Accuracy tests – external influences performance verification.

<sup>47</sup> ANSI C12.1-2008, §5.1.2 Accuracy requirements, §5.1.2.1 Test loads.

<sup>48</sup> Luthan, based out of Owensboro, Kentucky, and has been providing meter testing services to electric providers for over 11 years, including testing over 70,000 advanced meters. Luthan’s meter technicians are all certified by the Kentucky Public Service Commission, some with over 25 years experience.

<sup>49</sup> MET Labs, based out of Baltimore, Maryland, is a leading testing and certification laboratory that provides a complete range of ANSI C12 accuracy testing. They specialize in verifying the performance and accuracy of electric meters under different environmental or fluctuating voltage conditions.

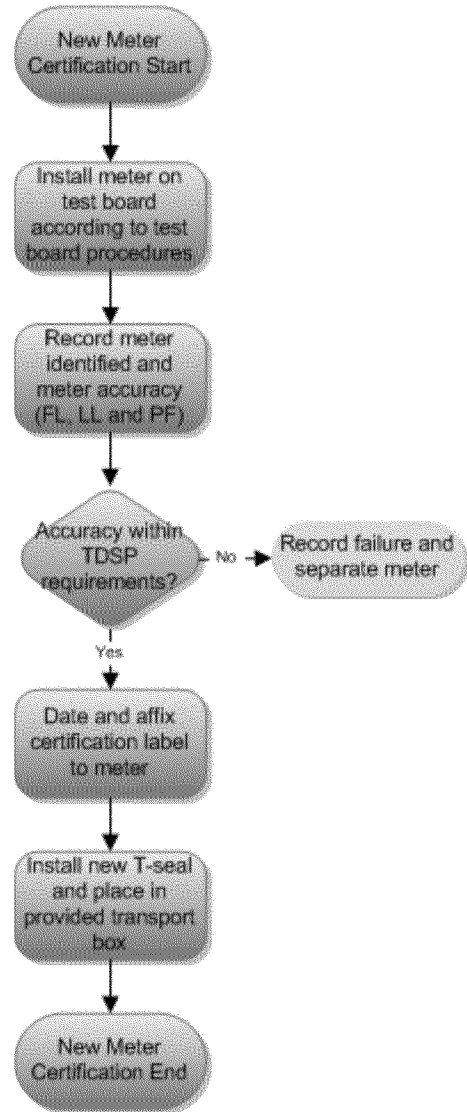
Accuracy tests of the ,New ' and ,Deployed ' advanced meters were performed at Luthan's testing facility ( ,Bench Testing ' ). Testing of the advanced meters still in-service was also performed by Luthan in the field at the location of the installed meter using mobile testing units and portable test devices ( ,Field Testing ' ). The comparison testing of advanced and electromechanical meters ( ,Side-by-Side Testing ' ) was performed by MET Labs in a laboratory environment.

a) Bench Testing of ,New ' Advanced Meters

A sample of 2,400 ,New ' advanced meters was identified by Navigant Consulting for independent meter accuracy testing. Random samples of 1,152 ,New ' meters were selected for both Oncor and CenterPoint. A sample of 96 ,New ' meters was selected for testing at AEP Texas. Given that AEP Texas had recently started deployment of advanced meters in its service territory, a smaller sample size was selected.

The samples were selected from the respective TDSP warehouse and deployment sites based on advanced meters in inventory and ready for deployment.<sup>50</sup> Both Oncor and CenterPoint maintain significant inventories of advanced meters as each is currently in active deployment of meters across their service areas. Meters are typically packaged four (4) meters to a box and 24 boxes to a pallet (i.e., 96 meters). As such, 12 pallets or 1,152 meters were selected for testing from both Oncor and CenterPoint, and one (1) pallet from AEP Texas. The samples selected were from different shipments represented in the respective TDSPs' inventory.

The samples were sent directly to Luthan following defined written procedures and applicable chain of custody controls established by Navigant Consulting. An Accuracy Performance Check was conducted by Luthan on each meter following a prescribed testing procedure. A Navigant Consulting observer was present during each step of the sample selection and meter shipment process, as well as for the meter testing conducted by Luthan. A representative from the Commission also had an opportunity to inspect the Luthan test facility and observe the testing procedures. *Figure 12* outlines the general procedures followed by Luthan in conducting the accuracy testing on the samples of ,New ' and ,Deployed ' advanced meters.

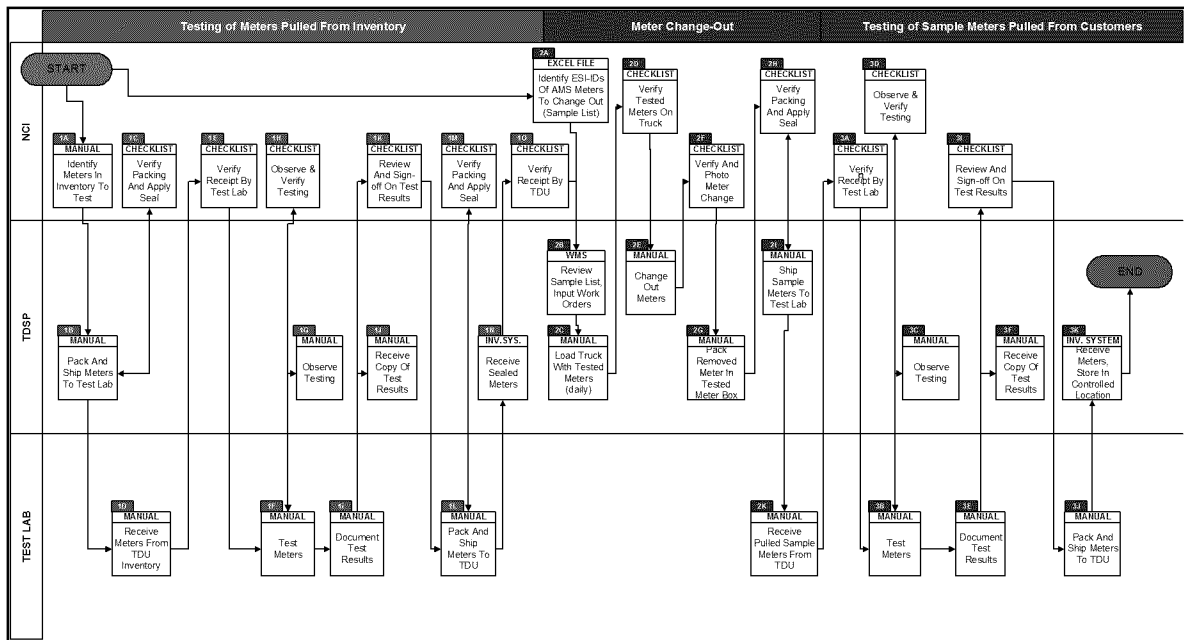


<sup>50</sup> Oncor, CenterPoint and AEP Texas conduct independent accuracy tests on a sample of new meters received in each shipment. The shipments are held in quarantine until cleared for use.

b) Bench Testing of ,Deployed' Advanced Meters

Upon completing the testing of the 2,400 ,New' meters, Navigant Consulting identified a random sample of approximately 2,400 ,Deployed' meters for testing. The samples were based on all Form 2S, Class 200 residential advanced meters that had been deployed by the TDSPs in their service territories with the exception of advanced meters that had only recently been deployed and/or had yet to be provisioned (i.e., approved) to use the automated reads. We also limited our sample to meters that were currently in service versus meters that were disconnected (e.g., vacant house).

The ,Deployed' advanced meters identified for testing were exchanged with the ,New' advanced meters that had been certified as accurate by Luthan. Navigant Consulting coordinated the retrieval and exchange of the ,Deployed' meters for the ,New' meters, ensuring that control and chain of custody procedures were followed.<sup>51</sup> A total of 2,213 ,Deployed' meters were removed from service during the meter exchanges. Certain meters were unable to be exchanged due to various reasons including billing cycle restrictions and problems gaining access to the meters. Navigant Consulting coordinated the shipment of the ,Deployed' meters to Luthan for accuracy testing and was present during each step of the meter accuracy testing process. The general work flow process followed by Navigant Consulting, the TDSPs and Luthan with regard to the meter exchanges is depicted in *Figure 13* below:



The general procedures followed by Luthan with regard to the accuracy testing of the ,New' and ,Deployed' advanced meters are summarized below in an excerpt from the applicable Statement of Work to the Subcontractor Services Agreement between Luthan and Navigant Consulting.

<sup>51</sup> Navigant Consulting personnel participated as observers in the change out of the advanced meters that was performed by trained in-house and contract crews managed by the respective TDSPs.

*Excerpt from Statement of Work (Subcontractor Services Agreement with Luthan)*

A. New Meter Certification Process

Prior to the start of testing, Subcontractor should validate that the meter test boards used have been verified and calibrated using a NIST traceable secondary watt-hour reference standard within the last 30 days. Documentation of this verification and calibration should be included with the New Meter Certification test results.

Subcontractor shall use the following testing and information recording procedures when conducting accuracy testing and certification of the New Meters together with industry standard calibration and test procedures:

1. Remove the meter from the transport container/box, install the watt-hour meter on the test board, verify the meter manufacturer and record the meter serial number and meter identifier (if different from the meter serial number).
2. Place the meter in test mode (if supported) and verify the meter is operational and record the starting kWh meter read from the display.
3. Test the meter at full load and light load amps.
4. Record the test results in percent registration for , as found ' and , as left ' runs. Meter test results should be captured electronically from the meter test equipment in a format and template to be agreed upon. All test results shall have two digits to the right of the decimal. Each meter test result record must include, at a minimum:
  - a. TDSP / Company Name
  - b. Reference standard
  - c. Test date and time
  - d. Test engineer
  - e. Meter serial number
  - f. Meter identifier
  - g. Meter manufacturer and model
  - h. Meter pulse constant (Ke)
  - i. Starting read – The kWh meter read from the meter display at the start of the meter test
  - j. Ending read – The kWh meter read from the meter display at the end of the meter test.
  - k. %FL - The percent registration of the meter when the meter's rated test voltage and test amps are applied to all of its elements simultaneously
  - l. %LL- The percent registration of the meter when the meter's rated test voltage and ten percent of its test amps are applied to all of its elements simultaneously.
5. If any meter is out of calibration as specified within ANSI C12 or according to the TDSP requirements (see below), affix a , DOES NOT MEET CALIBRATION ' sticker to the face of the meter and package the meter in a separate packing box. **Do Not Adjust Meter Calibration.**
  - For Itron Centron solid state meters with OpenWay communication modules, the calibration requirements are +/- 0.5% under FL and LL conditions.
6. Place the meter back in Normal mode (if Test Mode is supported by the meter).
7. Affix a , Meter Accuracy Certified by ' label to the meter (to be provided by Subcontractor) that includes the Subcontractor name and date of certification. The location for the label will be determined prior to testing and may be different for each TDSP.
8. Attach the meter cover to the meter and install the T-Seal to the meter.
9. If certified, return the meter back to the transport container/box in which the meter was originally shipped. Otherwise, separate the meter as described above.

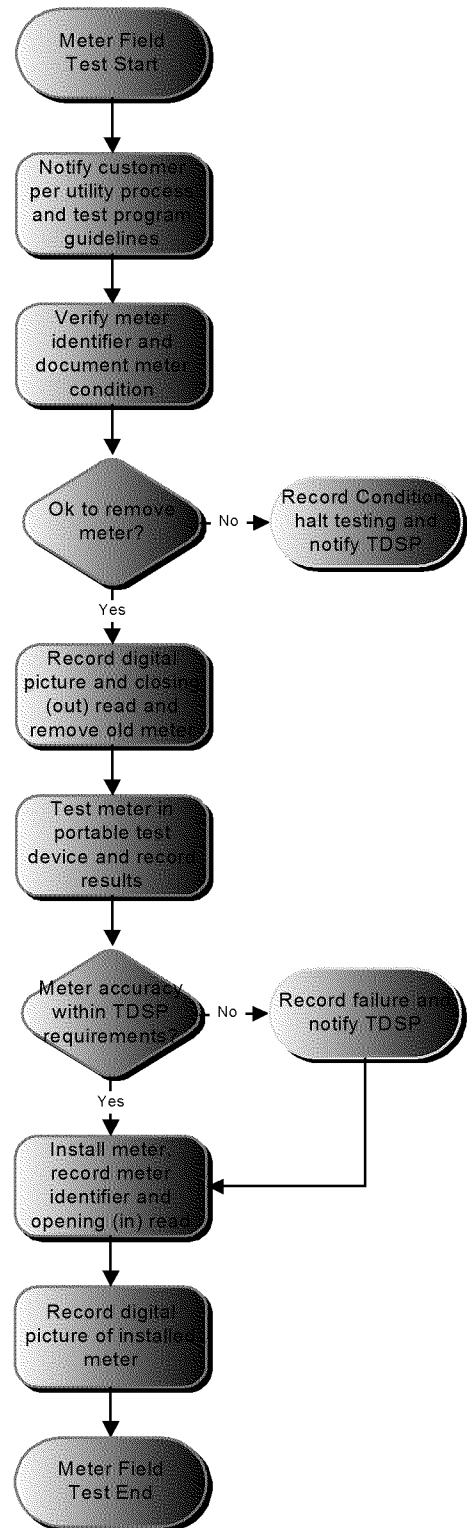
c) Field Testing of Advanced Meters

In addition to testing the ,New' and ,Deployed' advanced meters, Navigant Consulting also retained Luthan to conduct independent meter accuracy testing in the field on a sample of advanced meters in-service and use by customers in Oncor's service territory. Although the proposed independent testing pursuant to our discussions with the Commission and the TDSPs entailed primarily Bench Testing (i.e., testing in a laboratory setting), Oncor specifically requested that a sample of meters be tested at the customer's location or premise (i.e., ,Field Testing').

Pursuant to that request, Oncor made available to its customers the opportunity to request a meter accuracy test of their advanced meter by an independent third-party. Approximately 160 Oncor customers made a specific request for the independent meter accuracy tests. These requests, along with additional Oncor customers requesting accuracy tests of their advanced meters served as the basis of the meters tested during the Field Testing.

Three (3) mobile test crews were contracted from Luthan to perform the Field Testing, which took approximately one-month to complete. The mobile test crews utilized two (2) portable hand-held test devices and a bench-mounted test device in a van. The in-service residential advanced meters were temporarily removed from service, tested on-site with mobile meter test equipment, and reinstalled. The results of the meter accuracy tests were provided to customers upon completion either in person or through the use of a ,door hanger' left at the customer's front door. Representatives from both Navigant Consulting and the Commission observed various aspects of the Luthan Field Testing of advanced meters.

Luthan Field Tested 521 advanced meters at customer premises in the Oncor service areas that included Dallas-Fort Worth and Killeen-Temple. The advanced meters tested included advanced meters in-service at the 160 Oncor customers who had specifically requested an independent meter test. *Figure 14* displays the general procedures followed by Luthan during the Field Testing.

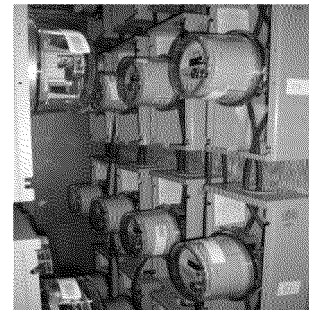
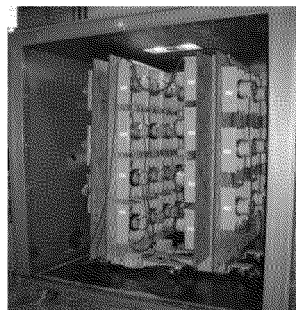
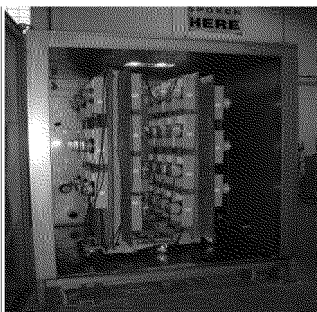
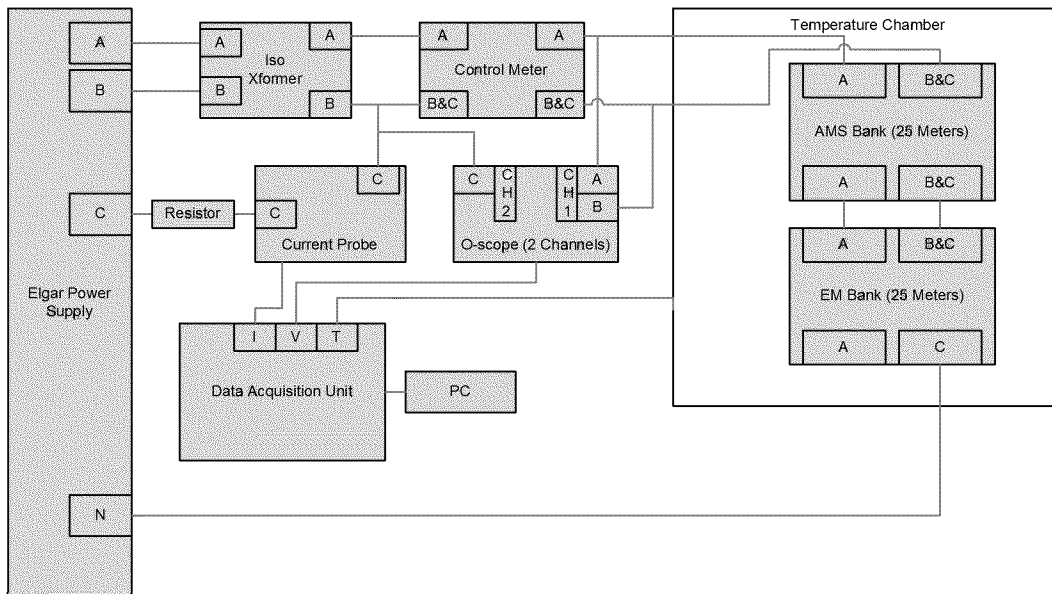


d) Side-by-Side Testing of Advanced and Electromechanical Meters

The Side-by-Side Testing involved simultaneous testing of advanced and electromechanical meters identified by Navigant Consulting from each of the TDSPs. At the direction of Navigant Consulting, the meters were initially sent to Luthan for meter accuracy testing prior to shipment to MET Labs for side-by-side comparison testing. During the Side-by-Side Testing, the advanced and electromechanical meters were subjected to load and temperature conditions representative of severe summer and winter conditions experienced in Texas. Representatives from Navigant Consulting, the Commission and TDSPs observed various aspects of the Side-by-Side Testing.

The Side-by-Side Testing was performed in an environmental chamber capable of adjusting the temperature between 0°F and 120°F and accommodating 50 residential watt-hour meters subjected to a specified load. The temperature and load varied each hour. *Figure 15* displays a diagram of the test set up along with photographs of meters loaded in the test chamber.

Side-by-side Meter Test Setup Diagram:



Navigant Consulting provided six (6) 24-hour Reference Load and Temperature Profiles corresponding to both a ,winter' and a ,summer' test sequence. The Reference Load and Temperature Profiles were repeated seven (7) times during each applicable seven (7) day sequence.



The Referenced Load and Temperature Profiles used are listed in *Table 1* below:

Reference Load and Temperature Profiles												
Hour	Dallas Region - (Oncor)				Houston Region - (CenterPoint)				Corpus Christi Region - (AEP)			
	Summer Test Sequence Profile		Winter Test Sequence Profile		Summer Test Sequence Profile		Winter Test Sequence Profile		Summer Test Sequence Profile		Winter Test Sequence Profile	
	Load (kW)	Temp. (F)	Load (kW)	Temp. (F)	Load (kW)	Temp. (F)	Load (kW)	Temp. (F)	Load (kW)	Temp. (F)	Load (kW)	Temp. (F)
1	2.3	88	4.3	23	2.0	82	3.3	30	2.1	81	4.1	28
2	2.1	88	4.4	22	1.8	82	3.2	29	2.0	81	4.2	29
3	2.0	88	4.6	21	1.6	81	3.1	28	1.8	81	4.0	28
4	1.8	86	4.9	19	1.5	81	3.3	27	1.7	79	3.9	28
5	1.7	85	5.1	19	1.4	79	3.7	27	1.6	79	4.5	27
6	1.7	84	5.7	18	1.4	79	4.2	27	1.6	79	4.7	25
7	1.6	84	6.3	18	1.4	79	4.4	27	1.5	79	5.0	27
8	1.6	84	6.3	18	1.4	81	4.4	26	1.5	80	4.9	26
9	1.7	88	5.7	16	1.5	86	4.7	27	1.8	86	5.3	27
10	2.1	91	5.2	18	1.9	90	4.3	27	2.1	90	4.8	30
11	2.4	92	4.9	18	2.2	93	4.0	28	2.4	93	4.3	34
12	2.8	97	4.2	21	2.6	95	4.3	30	2.7	97	3.4	34
13	3.1	99	3.7	25	3.0	97	3.9	32	2.9	99	3.3	36
14	3.3	99	3.5	26	3.2	99	3.7	32	3.1	100	2.9	38
15	3.5	102	3.3	28	3.4	100	3.4	32	3.3	100	2.6	41
16	3.7	102	3.3	30	3.6	102	3.1	30	3.3	100	2.3	43
17	3.9	103	3.6	30	3.8	102	3.3	30	3.3	99	2.1	45
18	4.0	102	4.4	28	3.9	102	3.6	30	3.3	93	2.1	43
19	4.0	102	4.7	25	3.9	100	4.7	30	3.2	90	2.7	39
20	3.8	101	4.8	24	3.7	100	4.8	30	3.0	89	2.9	38
21	3.6	97	5.0	21	3.5	95	4.7	30	2.8	84	3.1	36
22	3.4	93	4.9	21	3.4	91	5.0	28	2.6	82	3.4	36
23	3.0	93	5.0	20	3.1	90	5.4	27	2.6	82	3.5	32
24	2.6	90	5.4	19	2.8	88	5.4	27	2.4	81	3.8	32

### 3. Review of Historical Testing Procedures

In addition to the independent meter accuracy testing performed at the direction of Navigant Consulting, we also evaluated the results of the historical meter accuracy testing performed by the meter manufacturers (Itron and Landis+Gyr), as well as results of the meter accuracy testing performed by the respective TDSPs. Landis+Gyr and Itron test 100% of their meters before they are shipped, with the results provided to the respective TDSPs prior to, or upon, delivery of the new meters. The manufacturer also performs additional sample or lot testing before shipment.<sup>52</sup>

The TDSPs select an additional sample from each shipment of advanced meters for further testing by their meter shops.<sup>53</sup> A shipment will be held in quarantine (i.e., unavailable for deployment or use) until the sample testing procedures are complete. The TDSP meter shop also performs testing of either advanced or electromechanical meters as needed to evaluate meter performance or accuracy. The TDSPs also have the ability to test meters in the field with portable test equipment.

<sup>52</sup> ANSI C.12.1-2008, §5 *Standards for in-service performance*, requires accuracy tests to be performed on new metering devices by either the manufacturer or the utility and, if tested by the manufacturer, requires 100% of meters to be tested.

<sup>53</sup> Each TDSP maintains its own meter shop equipped with meter testing equipment that is periodically certified with watt-hour standards traceable back to national standards maintained by NIST.

**F. Observations and Findings**

Navigant Consulting conducted independent accuracy tests with the assistance of Luthan on over **5,100 advanced meters** in use by Oncor, CenterPoint and AEP Texas including testing **2,400 “New” meters, 2,213 “Deployed” meters, and 521 meters** in the field. An overview of the meter accuracy tests conducted on advanced meters and the results is provided in *Table 2* below:

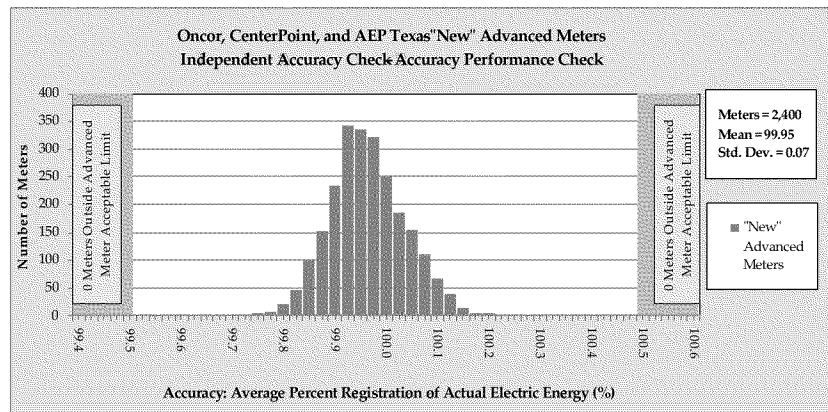
Summary of Meter Accuracy Test Results								
TDSP	Bench Testing				Field Testing		Total	
	"New" Meters	Failed (98% - 102%)	"Deployed" Meters	Failed (98% - 102%)	Meters Tested	Failed (98% - 102%)	Meters Tested	Failed (98% - 102%)
Oncor	1,152	-	1,042	2	521	-	2,715	2
CenterPoint	1,152	-	1,075	-	n/a	-	2,227	-
AEP Texas	96	-	96	-	n/a	-	192	-
<b>Total</b>	<b>2,400</b>	<b>-</b>	<b>2,213</b>	<b>2</b>	<b>521</b>	<b>-</b>	<b>5,134</b>	<b>2</b>

1. Accuracy Testing of ,New' and ,Deployed' Advanced Meters

a) ,New' Advanced Meters

Random samples of 1,152 ,New' meters were selected for accuracy testing for Oncor and CenterPoint, and 96 meters for AEP Texas. The meters were tested at Full Load, Light Load and Power Factor. Based on the results of the accuracy tests, **all 2,400 “New” advanced meters were determined to be accurate** by ANSI standards, as well as within Oncor, CenterPoint, and AEP Texas' expected performance of +/- 0.5%. In other words, all meters registered kilowatt hour (kWh) usage between 99.5% and 100.5% of what was expected.

Figure 16 displays a histogram of the meter accuracy test results.<sup>54</sup> The height of each bar (i.e., vertical axis) denotes the number of meters within the range of accuracy measured by the horizontal axis. The detail testing results on the ,New' meters is provided in *Exhibit 1*.

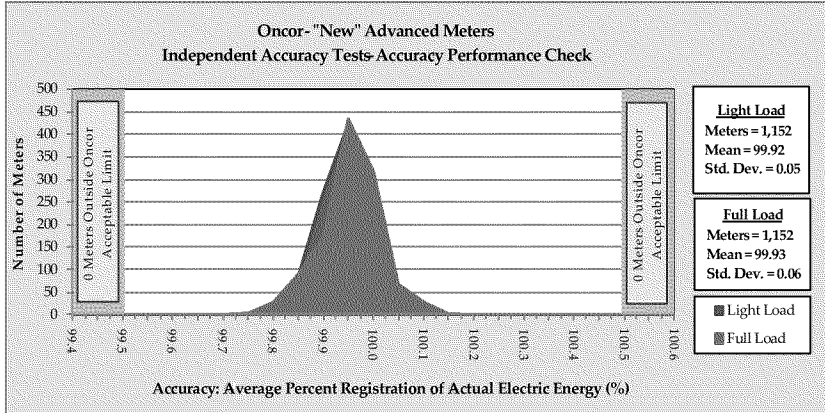


*The average accuracy of the 2,400 advanced meters tested was 99.95%, and all were within existing ANSI standards. All meters were also within the expected performance of +/- 0.5%.*

<sup>54</sup> A histogram is a graphical data display for presenting the distribution of variables across a range of values. The width of each bar represents the range of values (or test results) summarized in that bar and the height represents the number of test results falling within than range.

The 'percentage registration' or accuracy of an electric meter may be different at Light Load than at Full Load, which is one reason the Accuracy Performance Check includes accuracy tests at both in an effort to simulate different conditions for a meter during normal operations (e.g., sometimes the customer will be using more electricity and sometimes less). However, it is common to refer to the 'average percent registration' (i.e., the average meter accuracy at Full Load and Light Load) when evaluating the accuracy of an electric meter.<sup>55</sup>

Figure 17 compares the meter accuracy tests for Oncor 'New' meters at Full Load and Light Load. The test results were generally consistent. For the remainder of the Report, reference to meter accuracy will be to the average percentage registration unless otherwise specified.



*Meter accuracy test results at Full Load and Light Load were generally consistent for the advanced meters tested. On average, the meters tested were 99.9% accurate at Full Load and Light Load.*

b) 'Deployed' Advanced Meters

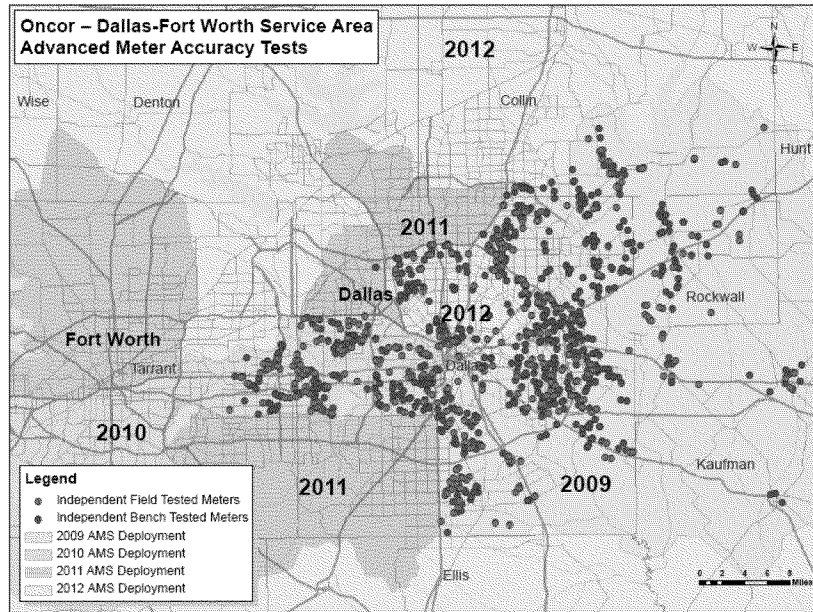
Random samples of 1,152 advanced meters for Oncor and CenterPoint, and 96 advanced meters for AEP Texas, that had been 'Deployed' by the TDSPs were also selected for accuracy testing. 2,213 advanced meters were removed from service during the meter exchange process at each TDSP as previously described. Not all meters identified in the random samples were removed from service as certain practical limitations prevented the meter change out crews from retrieving all of the 'Deployed' meters in question. Restrictions included, among others, no access to certain properties and billing cycle restrictions. The inability to retrieve certain meters during the meter change out did not have an impact on the validity of our sample or sampling process.

The random samples and sample sizes were generally selected based on the total number of advanced meters currently deployed by Oncor, CenterPoint and AEP Texas and therefore are believed to be representative of the various service areas for each of the TDSPs that had received advanced meters.

<sup>55</sup> There are two (2) common methods for determining the average percentage registration of a watthour meter. Method 1 calculates a weighted average where the full load is weighted at 80% and the light load at 20%. Method 2 calculates a simple average of the full load and light load where both are given equal weight. See ANSI C12.1, §5.1.5 Determination of average percentage registration.

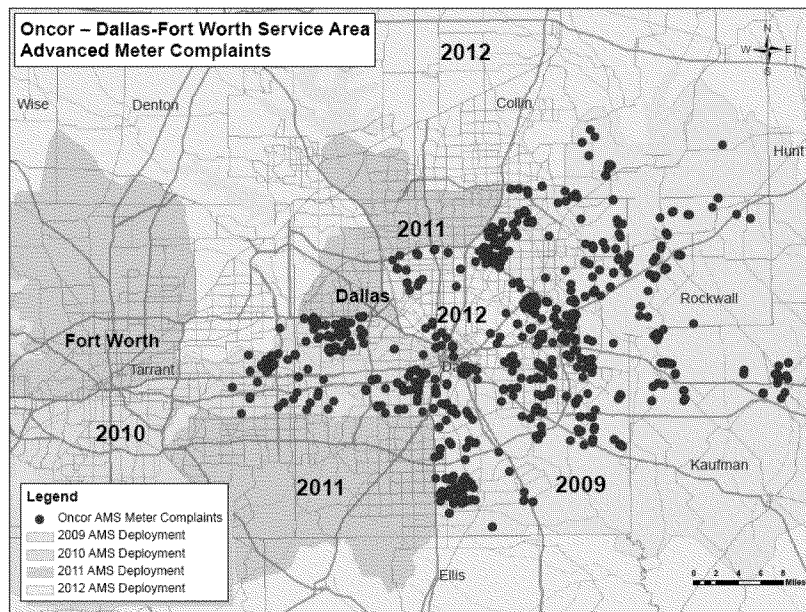
(i) *Oncor “Deployed” Advanced Meter Accuracy Tests*

Figure 18 denotes the relative locations (i.e., geographic dispersion) of the advanced meters identified for accuracy testing in the Dallas-Fort Worth area of Oncor’s service territory (*Killeen-Temple is displayed in Figure 21*). At the beginning of testing, Oncor had deployed advanced meters in the indicated 2009 deployment area and had started deployment in the 2010 area.



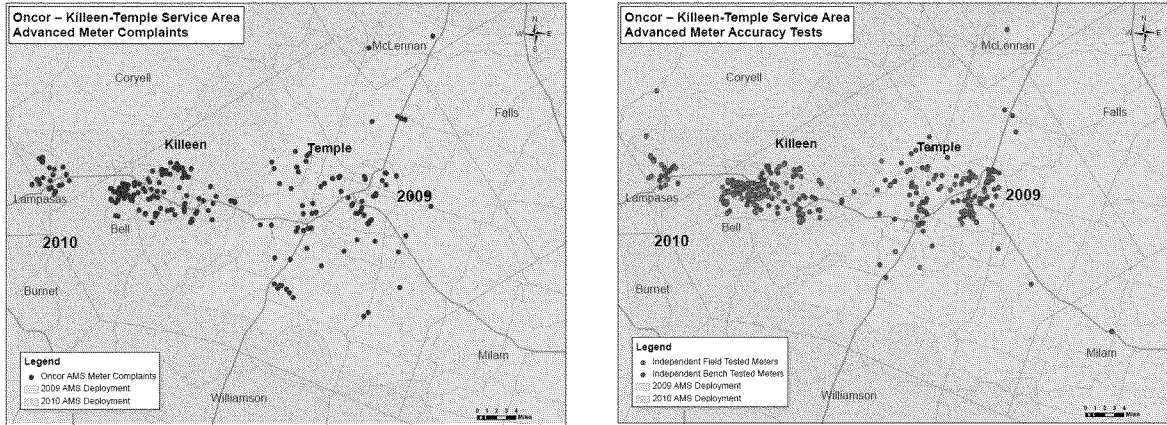
*Meter accuracy tests (Bench Testing and Field Testing) were conducted on advanced meters that had been deployed across the Dallas-Fort Worth area.*

Figure 19 denotes the relative locations of customers with advanced meters in the Oncor (Dallas-Fort Worth) service area (*Killeen-Temple is displayed in Figure 20*) with applicable complaints. Oncor customers with advanced meters who had made a complaint to the Commission regarding a billing question or concern were mapped to identify if geographic patterns or concentrations existed.



*Customer complaints to the Commission regarding billing questions or concerns were geographically dispersed across Oncor’s (Dallas-Fort Worth) advanced meter deployment area.*

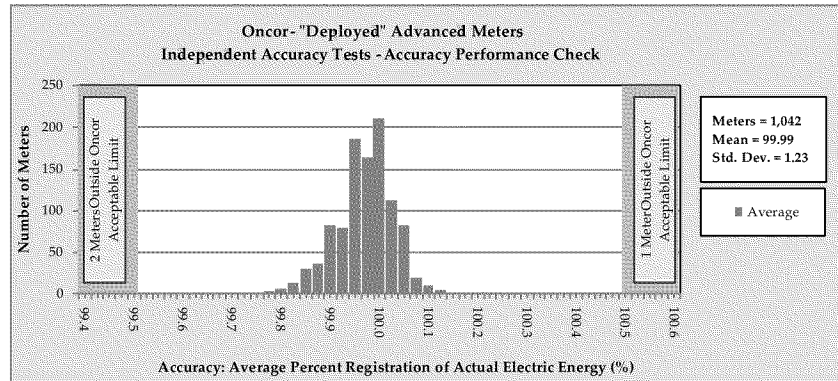
Figures 20 and 21 below denote the location of the sample of meters (subject to both Bench Testing and Field Testing) in the Killeen-Temple area, as well as identified customer complaints.



Meter accuracy tests conducted by Luthan, as well as customer complaints to the Commission, were geographically dispersed across Oncor's (Killeen-Temple) advanced meter deployment area.

1,042 'Deployed' Oncor advanced meters were removed from service and sent to Luthan for an Accuracy Performance Check. All meters were tested at Full Load, Light Load and Power Factor. Based on the results of the accuracy tests, **1,040 meters were determined to be accurate** by ANSI standards. **Two (2) meters failed the accuracy test** (i.e., were out of calibration by more than +/- 2.0%). One (1) meter was found to be accurate to ANSI standards, but did not meet the performance expected by Oncor of +/- 0.5%. That meter tested as 99.4% accurate.

Figure 22 displays the histogram for the average accuracy of the 'Deployed' advanced meters tested for Oncor. The detail testing results on the accuracy of the 'Deployed' meters tested is provided in Exhibit 2.



99.8% of the Oncor advanced meters tested met ANSI standards for accuracy. With the exception of the two (2) meters that failed, the average accuracy of the advanced meters tested was 100%.

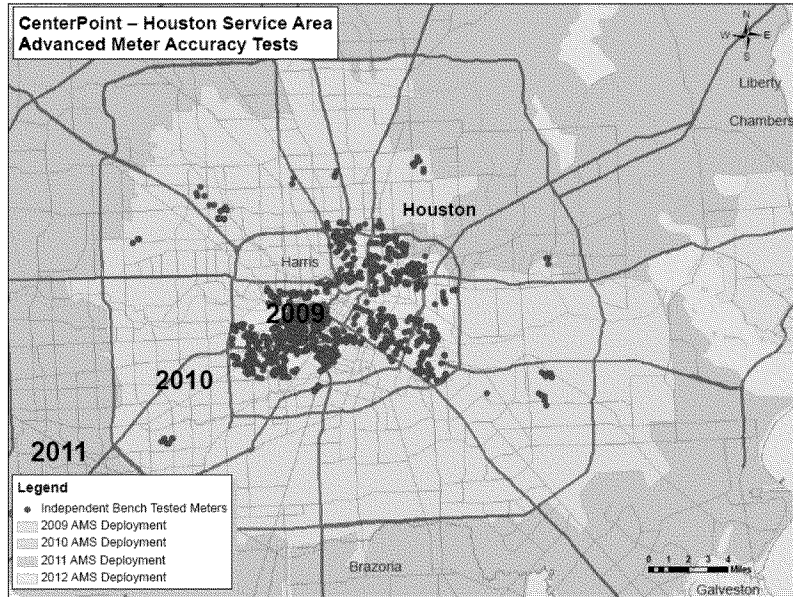
Investigation into the Two (2) Failed Meters

Additional analysis was performed on the two (2) meters found to be out of calibration including a joint investigation and analysis by representatives from Navigant Consulting, the Commission, Luthan, Oncor and Landis+Gyr (the manufacturer of the two meters in question). In addition, the

customers’ historical billing information was analyzed to determine whether billing adjustments are warranted. The results of our investigation are discussed in detail in Section X.

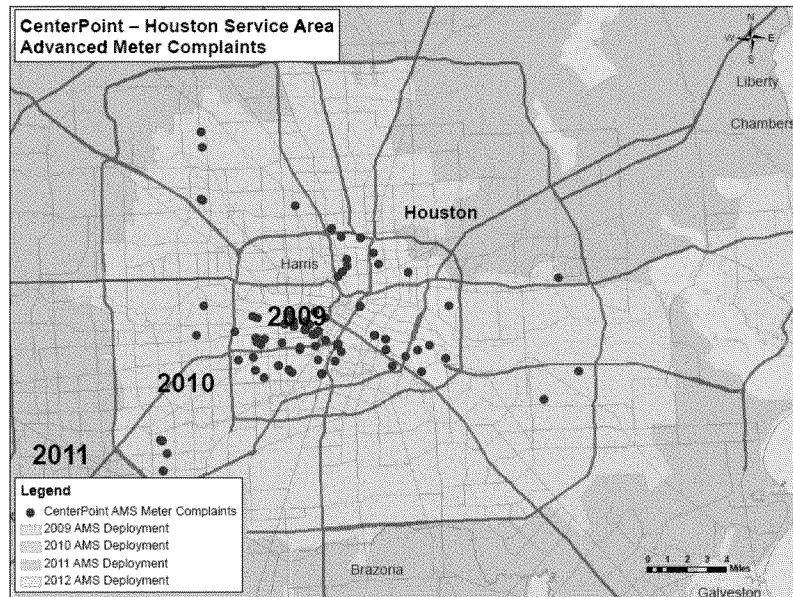
(ii) *CenterPoint “Deployed” Advanced Meter Accuracy Tests*

Figure 23 denotes the relative locations (i.e., geographic dispersion) of the advanced meters identified for accuracy testing in CenterPoint’s service territory (i.e., Houston). At the beginning of testing, CenterPoint had deployed advanced meters in the indicated 2009 deployment area and had started deploying advanced meters in the 2010 deployment area.



*Meter accuracy tests (Bench Testing) were conducted on advanced meters that had been deployed across the CenterPoint (Houston) service area.*

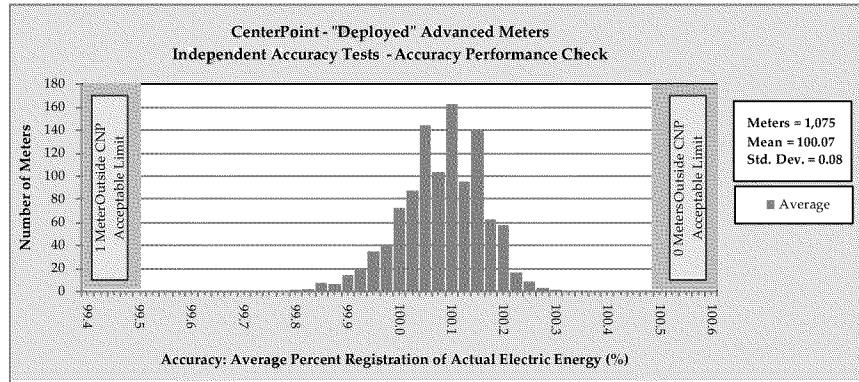
Figure 24 denotes the relative locations of customers with advanced meters and applicable complaints in the CenterPoint (Houston) service area. The relative distribution of customers who made complaints to the Commission in relation to a billing related concern was evaluated and mapped to determine if geographic patterns or concentrations existed that required further review.



*Customer complaints to the Commission regarding billing questions or concerns were geographically dispersed across CenterPoint’s (Houston) advanced meter deployment area.*

1,075 ,Deployed' CenterPoint advanced meters were removed from service and sent to Luthan for an Accuracy Performance Check. All meters were tested at Full Load, Light Load and Power Factor. Based on the results of the accuracy tests, **all 1,075 meters were determined to be accurate** by ANSI standards. One (1) advanced meter did not meet CenterPoint's expected performance of +/- 0.5%. That meter tested at 99.3% accuracy.

Figure 25 displays the histogram for the average accuracy of the ,Deployed' advanced meters tested for CenterPoint. The detail testing results on the accuracy of the ,Deployed' CenterPoint meters is provided in Exhibit 3.



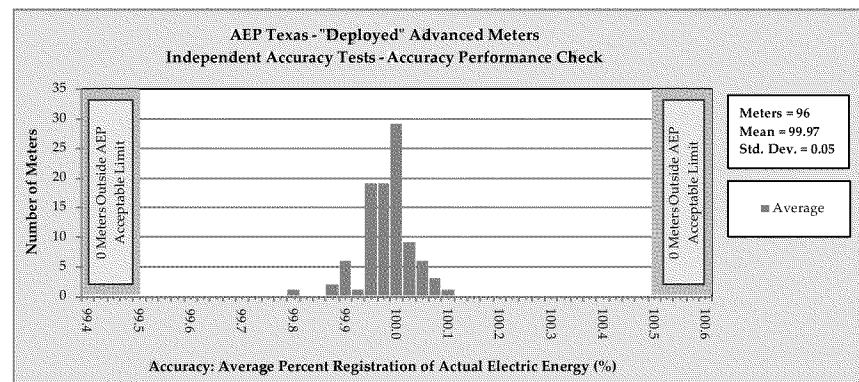
The 1,075 advanced meters tested met ANSI standards for accuracy, with an average accuracy of 100.07%. One (1) advanced meter tested outside of CenterPoint's expected performance of +/- 0.5.

(iii) AEP "Deployed" Advanced Meter Accuracy Tests

Ninety-six (96) ,Deployed' advanced meters were identified for accuracy testing in the AEP Texas service area in South Texas. AEP Texas had deployed approximately 4,700 advanced meters in the Gregory-Portland area at the time and all advanced meters selected for testing came from this area.

The ninety-six (96) ,Deployed' advanced meters were removed from service and sent to Luthan for an Accuracy Performance Check. All meters were tested at Full Load, Light Load and Power Factor. Based on the results of the accuracy tests, **all meters were determined to be accurate** by ANSI standards, as well as within AEP Texas' expected performance of +/- 0.5%.

Figure 26 displays the histogram for the average accuracy of the advanced ,Deployed' meters tested for AEP Texas. The detail results of the testing performed on the ,Deployed' AEP Texas meters is provided in Exhibit 4.



The average accuracy of the 96 advanced meters tested was 99.97%, and all were within existing ANSI standards. All meters tested were also within AEP Texas' expected performance of +/- 0.5%.

2. Accuracy Testing of Advanced Meters in the Field (Field Testing)

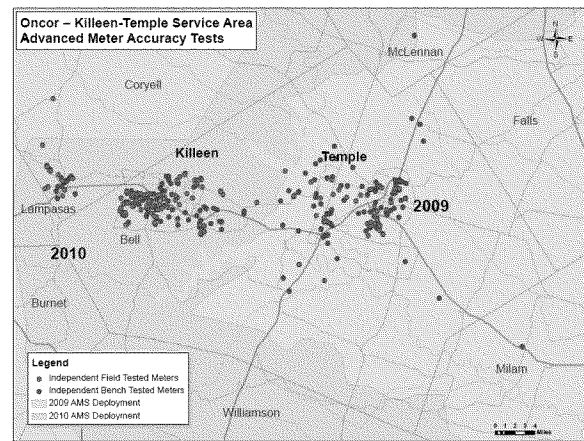
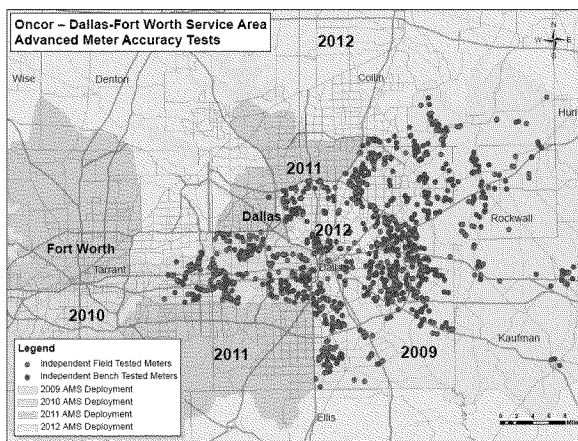
At the request of Oncor, Navigant Consulting included in its scope of work independent Field Testing of a sample of advanced meters deployed in Oncor’s service territory. Over 160 Oncor customers specifically requested a meter accuracy test by an independent third-party. A random sample of additional customers was also selected from Oncor customers who had made a general request for their advanced meter to be tested.

Approximately 582 Oncor customers with advanced meters were identified for Field Testing, including the 160 customers who specifically requested an independent meter accuracy test. Navigant Consulting contracted with Luthan to provide the Field Testing. Of the 582 meters identified for Field Testing, 521 meter accuracy tests were successfully completed. **Table 3** summarizes the Field Testing including reasons why certain meters were not tested.

Summary of Field Testing by Luthan – Meter Accuracy Tests						
Tests Attempted	Tests Unable to be Performed					Tests Completed
	Inaccessible (Gated/Locked)	Service Disconnected	Customer Declined Test	Potential Tampering	Other	
582	27	12	10	7	5	521

As indicated in the above table, Luthan encountered various obstacles in Field Testing all of the advanced meters identified, many of which are common to what meter readers and service technicians face in the field each day (i.e., gated and locked areas or other restricted access, customer interference, etc.). The seven (7) meters where evidence of potential tampering was observed were referred to Oncor’s Revenue Security department for investigation. The meters were not tested to preserve any potential evidence of tampering for further investigation.

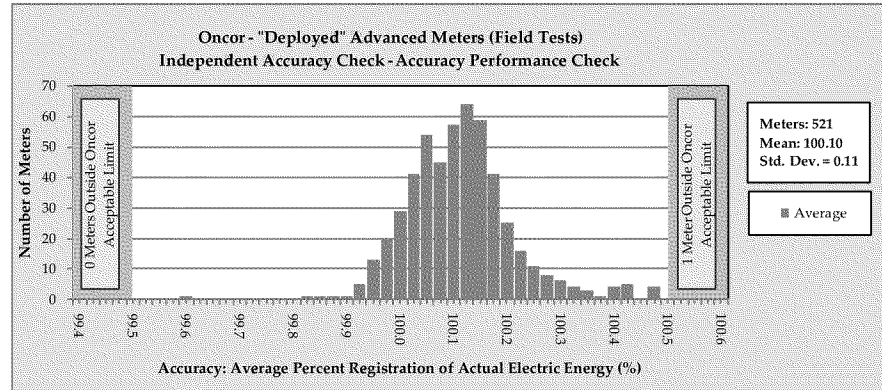
**Figures 27 and 28** denote the relative locations (i.e., geographic dispersion) of the advanced meters identified for Field Testing in the Dallas-Fort Worth and Killeen-Temple areas of Oncor’s service territory. At the beginning of testing, Oncor had deployed advanced meters in the indicated 2009 deployment areas and had started deploying meter in the 2010 deployment area.





521 advanced meters were Field Tested by Luthan using certified hand-held and a mobile bench-mounted accuracy testing device. All meters were tested at Full Load, Light Load and Power Factor. Based on the results of the accuracy tests, **all meters were determined to be accurate** by ANSI standards. One (1) meter did not meet Oncor’s expected performance of +/- 0.5%. That meter tested at 100.94% accuracy.

Figure 29 displays the histogram of the test results for advanced meters Field Tested by Luthan. The detail results of the ‘Field Testing’ performed on advanced meters for Oncor is provided in Exhibit 5.



The 521 advanced meters tested met ANSI standards for accuracy, with an average accuracy of 100.1%. One (1) advanced meter tested outside of Oncor’s expected performance of +/- 0.5.

Ten (10) meters visited during the Field Testing required additional follow-up. These meters are discussed in more detail below:

- One (1) meter had a lock on it that was not an Oncor issued lock.
- Three (3) meters were noted with a maximum demand greater than 45 kW, which seemed excessive to the Luthan meter technician. The meters are being investigated by Oncor.
- Three (3) meters were noted with some aspect of damage including one (1) meter that appeared to experience an electrical short during the meter accuracy testing. The meter was replaced and is undergoing further investigation.
- One (1) meter appeared to count back 5 kWh after completion of the meter accuracy test. The meter was retested with no unusual observations. The meter was replaced and the issue is under further investigation.
- Two (2) meters identified for accuracy testing were not found at the customer premise indicating that the meters had been exchanged recently for new meters. The meters were subsequently located by Oncor, and had been removed pursuant to a work order.

### 3. Side-by-Side Testing of Advanced and Electromechanical Meters

Side-by-Side Testing of 25 advanced and 25 electromechanical meters for Oncor, CenterPoint and AEP Texas was conducted by MET Labs in its Baltimore, Maryland testing laboratory. A total of 32 advanced and 32 electromechanical meters were identified and shipped to MET Labs from meters identified at each of the TDSPs, from which a random sample of 50 meters (i.e., 25 advanced and 25 electromechanical meters) were chosen for testing.

All 50 meters were installed in an environmental chamber and subjected to a varying load and temperature profile intended to simulate some of the more extreme temperatures and operating conditions for an average customer in Texas. The kilowatt hour (kWh) usage registration was read at the beginning and end of each test (i.e., 'summer sequence' and 'winter sequence'). The kilowatt (kWh) usage recorded on the meters was compared to the calculated amount of kilowatt hour (kWh) usage expected based on the amount of load applied.

The results of the Side-by-Side Testing of meters provided by MET Labs included the identified load and calculated expected kilowatt hour (kWh) usage per meter along with the observed pre and post-testing kilowatt hour (kWh) readings, as well as the actual kilowatt (kWh) usage. An example of the data generated for CenterPoint's meters is provided below in *Table 4* with the detailed results for Oncor, CenterPoint and AEP Texas provided in *Exhibits 6, 7, and 8*.

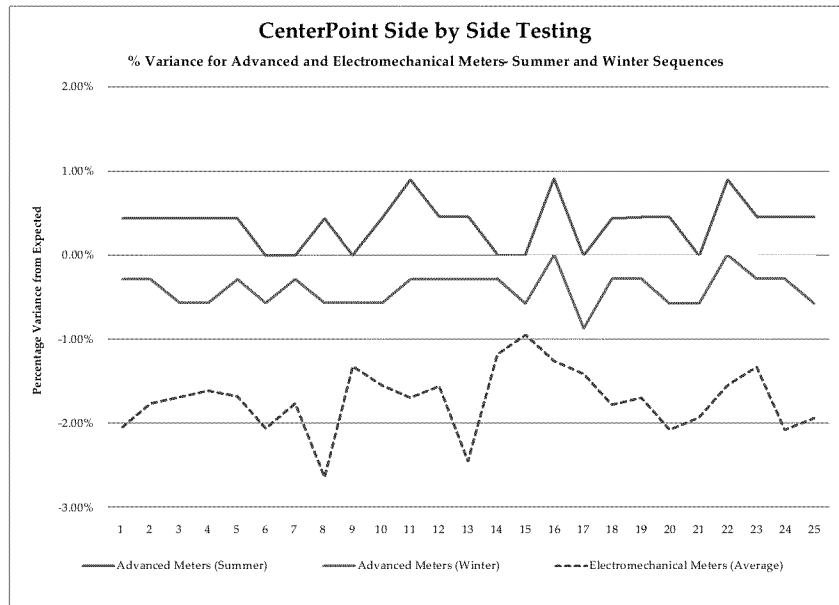
Test:	Side-by-Side Testing - Houston Region Summer Test					
TDSP:	CenterPoint					
Meter Type:	Itron Advanced Meter					
Test Start Date:	May 20, 2010					
Test End Date:	May 28, 2010					
Sample Results:	Sample 1	Sample 2	Sample 3	Sample 4		Sample 25
Serial Number:	62 242 546	60 934 431	60 941 592	61 323 861		60 083 842
Current Class:	200	200	200	200	→	200
Form:	2S	2S	2S	2S		2S
Test Voltage (V):	239.9	239.9	239.9	239.9		239.9
Test Current:	11.4	11.3	11.2	11.3		10.9
Number of Elements for Test:	0.5	0.5	0.5	0.5	→	0.5
Expected Duration (Hrs):	168	168	168	168		168
Expected kWh:	228	227	226	228		220
Meter Read - Pre kWh Value:	4586	7780	4081	3822		23393
Meter Read - Post kWh Value:	4815	8008	4308	4051		23614
Actual kWh:	229	228	227	229	→	221
Actual Less Expected:	1	1	1	1		1
% Variance:	0.4%	0.4%	0.4%	0.4%		0.5%

The aggregated results of the summer and winter sequences for the samples of advanced and electromechanical meters in the Side-by-Side Testing are provided in *Table 5* below.

Side-by-Side Testing	Advanced Meters					Electromechanical Meters				
	Avg. kWh Usage		Difference			Avg. kWh Usage		Difference		
Independent Tests (Met Labs)	Actual	Expected	Min.	Max.	Avg.	Actual	Expected	Min.	Max.	Avg.
<b>Oncor</b>										
Summer Test Sequence	236	236	(2)	0	0	230	234	(9)	(1)	(4)
Winter Test Sequence	404	406	(3)	0	(2)	398	404	(11)	(2)	(6)
<b>CenterPoint</b>										
Summer Test Sequence	225	224	0	2	1	217	220	(6)	(1)	(3)
Winter Test Sequence	349	350	(3)	0	(1)	340	347	(9)	(4)	(7)
<b>AEP Texas</b>										
Summer Test Sequence	209	209	(1)	1	0	205	208	(8)	1	(3)
Winter Test Sequence	314	316	(2)	0	(1)	308	313	(10)	5	(5)

It is important to note, that there were certain limitations on the precision of kilowatt hour usage measurements for both the advanced and electromechanical meters. While the applied load and expected kilowatt hour usage could be measured more precisely to a certain number of decimal points, the readings on the advanced and electromechanical meters were limited to integers (i.e., whole kilowatt hours). As such, the results presented above are believed to be representative, within a range of precision considered to be no less than approximately +/-1%. With that understanding, the advanced meters demonstrated results that were consistent with what was expected and the electromechanical meters, on average, appeared to run slower than expected.

*Figure 30* is a graph of the % variance from expected for the CenterPoint meters. The advanced meters tested within the same relative range of performance. The difference between the winter and summer test sequences was within the range of precision for the Side-by-Side Testing. The electromechanical meters appear, on average, to have run slower than expected.



*Figure 31* is a graph of the % variance from expected for the Oncor meters. The advanced meters tested within the same relative range of performance. The difference between the winter and summer test sequences was within the range of precision for the Side-by-Side Testing. The electromechanical meters appear, on average, to have run slower than expected.

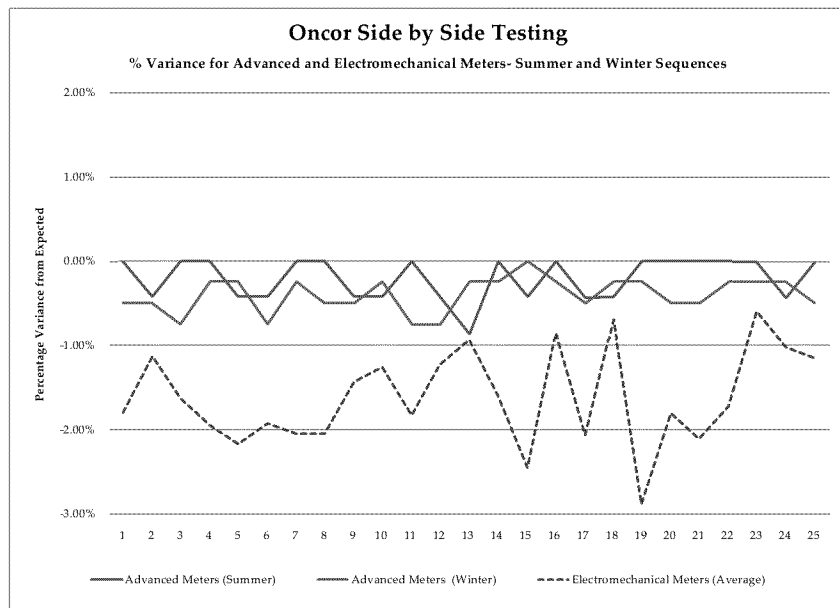
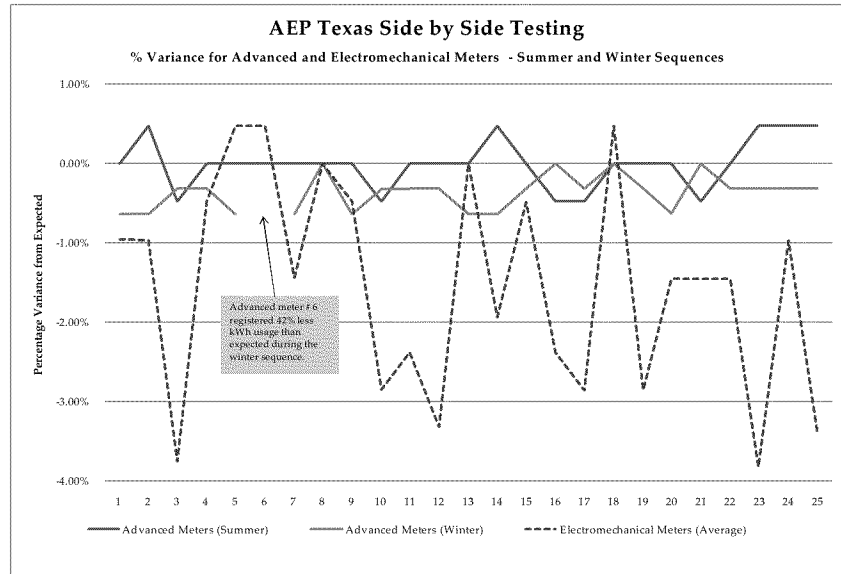


Figure 32 is a graph of the % variance from expected for the AEP Texas meters. The advanced meters tested within the same relative range of performance. The difference between the winter and summer test sequences was within the range of precision for the Side-by-Side Testing. The electromechanical meters appear, on average, to have run slower than expected.

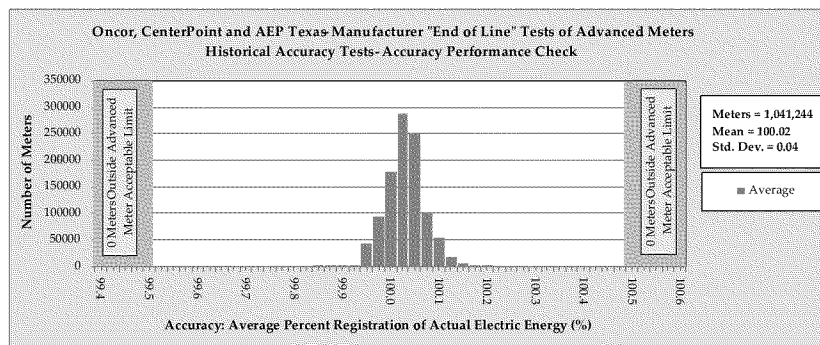


One (1) AEP Texas advanced meter ceased to perform during one sequence of the Side-by-Side Testing and registered kilowatt hour usage significantly below what was expected. This meter was subsequently returned to the manufacturer (Landis+Gyr) for evaluation and is discussed in more detail in Section X. *Review of Identified Issues and Corrective Actions* of the Report.

4. Testing Results in Comparison to Manufacturer and Other Historical Tests

Navigant Consulting also obtained the accuracy test results performed by the manufacturers of the advanced meters deployed by Oncor, CenterPoint and AEP Texas. Landis+Gyr and Itron test 100% of the advanced meters they manufacture prior to shipping to the TDSPs, including tests consistent with the Accuracy Performance Check. The results of these so-called End-of-Line tests are forwarded to Oncor, CenterPoint and AEP Texas upon shipment of the respective meters. We received and evaluated the meter accuracy test results of over one million advanced meters deployed by Oncor, CenterPoint and AEP Texas. All advanced meters tested accurate.

Figure 33 displays the histogram of the advanced meter accuracy test results conducted by Landis+Gyr and Itron for advanced meters shipped to Oncor, CenterPoint and AEP Texas. The meters tested 100% accurate.



The results of the meter accuracy tests conducted by Navigant Consulting and Luthan are consistent with the results of the End of Line tests conducted by the respective manufacturers. The meters for Oncor, CenterPoint and AEP Texas on average tested in the range of 99.9% to 100%.

The results of the accuracy tests performed by the manufacturers appear to fall within a narrower band (i.e., slightly more accurate) than the accuracy tests conducted by Luthan. However, that is expected. Testing by the manufacturers is required to be performed under more stringent test conditions including precise temperatures, voltage and test amperes that are more difficult to achieve and maintain in a standard meter test shop or laboratory, as well as in the field. Differing test conditions can introduce very slight differences in the accuracy of the meter testing equipment, as well as potentially the advanced meters themselves. Nonetheless, the advanced meters tested were consistent with the test results from (1) the manufacturer, (2) as shipped to the TDSP prior to deployment, and (3) after the advanced meters had been deployed.

#### 5. Accuracy of Advanced Meters in Comparison to Electromechanical Meters

Advanced meters are designed to operate at a higher degree of accuracy than the older electromechanical meters they are replacing. That is not to say that electromechanical meters are not capable of operating at 100% accuracy. They are. In reality however, electromechanical meters operating in the field are not as accurate as the advanced meters that are currently being deployed.

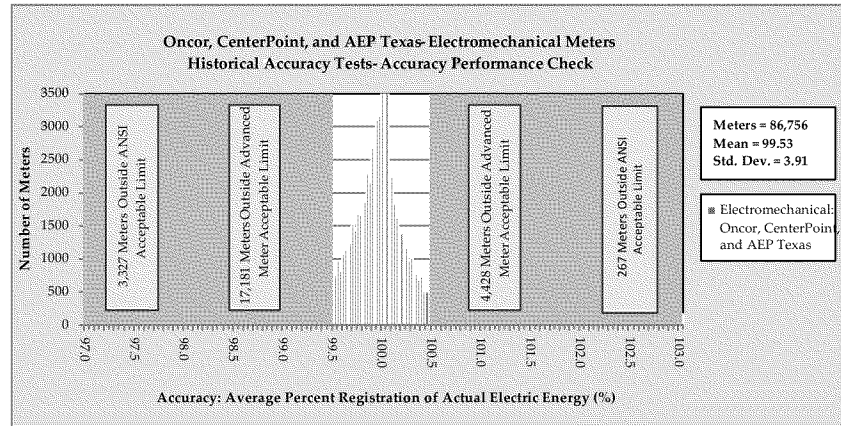
The Commission requires both electromechanical and advanced meters to be accurate within ANSI standards of +/- 2% (i.e., operate within a range of 98% - 102% accuracy). However, advanced meters are designed to perform at a higher degree of accuracy (i.e., 99.8% - 100.2% and 99.5% - 100.5% for 0.2 and 0.5 class advanced meters, respectively).

Although the accuracy testing of electromechanical meters was not a primary objective in Navigant Consulting's scope of work during the investigation, Navigant Consulting asked Luthan to conduct meter accuracy tests on a small number of electromechanical meters pursuant to the Side-by-Side Testing by MET Labs. In addition, Navigant Consulting requested and evaluated the historical results of a sample of electromechanical meters accuracy tested by the TDSPs.

Despite the small sample size, the relative accuracy of electromechanical meters in comparison to advanced meters was evident in the 96 electromechanical meters accuracy tested by Luthan. Of the 96 electromechanical meters tested, **two (2) meters failed** to meet ANSI standards of +/- 2% for accuracy, and **26 meters (or 27%) were outside the +/- 0.5% performance criteria** used by Oncor, CenterPoint and AEP Texas to evaluate their advanced meters. In other words, 2 out of 96 electromechanical meters failed versus 2 out of over 5,100 advanced meters tested and 27% of the electromechanical meters were performing less accurately than the advanced meters tested.

In addition to evaluating the test results on the 96 electromechanical meters described above, we also evaluated the meter accuracy test results for 86,756 electromechanical meters recorded by Oncor, CenterPoint and AEP Texas. Of the 86,756 meters tested, **3,594 meters (or 4%) failed** to meet ANSI accuracy standards of +/- 2% and **21,609 meters (or 25%) were outside the +/- 0.5% performance** criteria currently used by Oncor, CenterPoint and AEP Texas for their advanced meters. In other words, 25% of these electromechanical meters were operating at a level that is currently not considered acceptable by Oncor, CenterPoint and AEP Texas for their advanced meters.

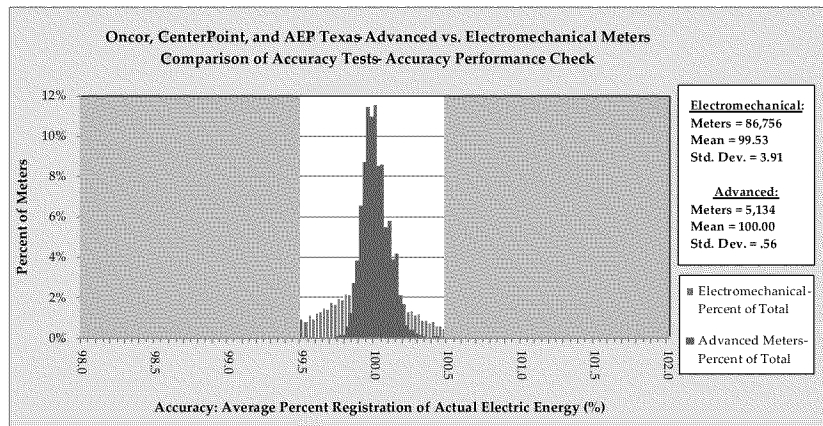
Figure 34 displays the histogram for 86,756 electromechanical meters tested by Oncor, CenterPoint and AEP Texas in the past. The histogram denotes the number of meters operating outside ANSI standards and TDSP performance criteria for advanced meters.



3,594 meters or 4% of electromechanical meters failed accuracy testing by ANSI standards and approximately 25% were performing below the expected performance of advanced meters.

By comparison, the advanced meters tested during the course of our investigation were determined to be significantly more accurate than either the 96 electromechanical meters tested by Luthan or the 86,756 electromechanical meters tested in the past by Oncor and CenterPoint.

Figure 35 displays the histogram of the meter accuracy test results for the 86,756 electromechanical meters tested by Oncor and CenterPoint in comparison to the 5,134 advanced meters tested by Navigant Consulting and Luthan pursuant to our investigation.

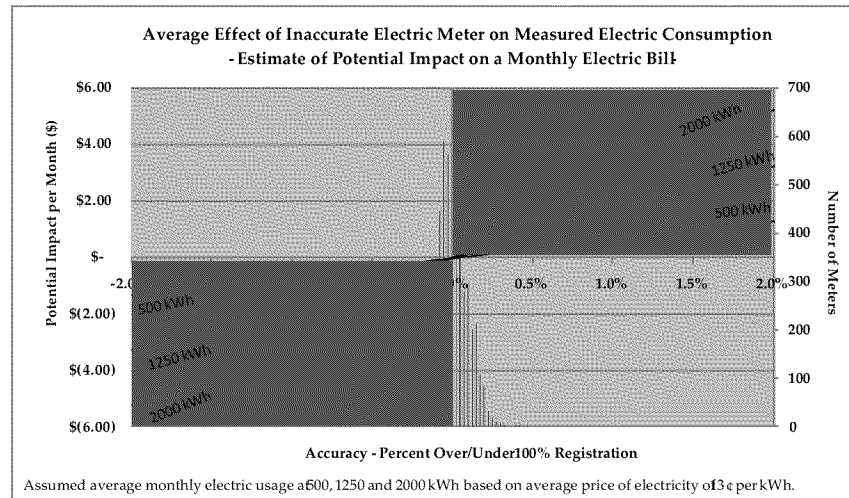


The 5,134 advanced meters tested pursuant to our investigation were significantly more accurate than the electromechanical meters tested by Oncor, CenterPoint and AEP Texas in the past.

#### 6. Potential Impact of Meters Outside of Acceptable Accuracy Standards

The differences in accuracy noted with regard to the advanced meters, as well as most of those observed above in relation to electromechanical meters, would not result in a sizable (i.e., noticeable) impact on the electric bills of most customers. Even a 1 – 2% difference, which would still be acceptable under ANSI standards, would result in only a small change to a customer’s monthly bill. While even a small difference (\$1 – \$2 per month) is still important to customers, such a percent difference in accuracy of an electric meter would not be responsible for the observed higher electric bills that were the basis of the various complaints to the TDSPs and the Commission.

Figure 36 displays the impact on an average customer's monthly bill due to the inaccuracy of their electric meter at different levels of usage (i.e., kilowatt hour consumption) in any given month.



As an example, a customer using 2,000 kWh per month with a meter that is inaccurate by 1.0% would see less than \$2.50 more per month on their monthly electric bill (assuming \$0.13/kWh).

#### 7. Overall Observations and Conclusions on AMS Meter Accuracy

Reliable and accurate electric usage measurement, as well as the recording, storing and communication of that information, is fundamental to a utility's operations and to its relationships with its customers. The use of electromechanical meters for that purpose has long-been established and accepted as both a reasonable and reliable means of recording a customer's usage. However, as with any enterprise involving human interaction such as the manual meter reading process for electromechanical meters, humans are prone to make mistakes. The advent of the advanced meter was intended not only to enhance the accuracy of meter reading by replacing the possibility of human error in the manual meter reading process, but also provide more useful, and timely, information to customers and the utility on the usage of electricity.

The anticipated benefits of advanced metering offers much more than the limited electromechanical meters, and offers it in a digital meter reading device that is designed to be significantly more accurate. However, as with any piece of technology, its accuracy and reliability is subject to the care with which it is afforded and to the proper design and integration of the technology into a larger system of integrated technologies capable of achieving the expected benefits.

During our tests, we identified a number of advanced meters that displayed evidence of potential tampering, some with damage, and others in conditions that one would not consider to be optimal for the advanced meter's use. Regardless, of the 5,100 advanced meters tested, *over 99.96% of the meters were found to be accurate – and found to be significantly more accurate than the electromechanical meters they are replacing.*

**VI. Evaluation of Advanced Meter Deployment**

**A. Background**

One of the primary tasks of Navigant Consulting’s scope of work included an assessment of the processes, written procedures, and controls developed by each TDSP to facilitate the successful use of advanced meters. Navigant Consulting’s assessment focused on three (3) distinct processes in the advanced meter deployment and integration effort:

1. **Advanced Meter Testing** - including TDSP first article testing, manufacturer production line testing, and sample testing by both the TDSP and manufacturer;
2. **Advanced Meter Deployment** - the physical installation of the advanced meter and initial advanced meter network communication establishment; and
3. **Advanced Meter Data Management** - the collection, storage, transformation, and transfer of data recorded by the meter in various information systems.

The first two (2) processes are addressed in this section of the Report. The Advanced Meter Data Management process is addressed in Section IX.

**B. Work Performed**

1. Advanced Meter Testing Process and Controls Review
  - a) Tour of Meter Shops

Navigant Consulting visited the meter operations facilities (i.e., meter shops) of Oncor, CenterPoint and AEP Texas to evaluate the meter testing facilities and associated equipment used in support of their advanced meter deployments. This review involved a detailed tour of each facility including advanced meter deployment warehouses, loading docks, meter storage areas (both pre-testing and post-testing) and meter testing areas. Navigant Consulting also reviewed the process documentation, checklists and inventory management systems in place at each utility to gain an understanding of each TDSP’s meter shop operations. Additionally, Navigant Consulting engaged in detailed discussions with TDSP meter shop personnel to gain a full understanding of their advanced meter testing and deployment activities.

- b) Observation of Meter Test Equipment Use

Navigant Consulting observed accuracy testing of a number of advanced meters using test boards manufactured by Watthour Engineering Company (, WECO' is one of the industry leaders in meter testing equipment) and verified the calibration reports and calibration intervals for these test boards relative to the manufacturer and ANSI standards (ANSI C12.1). In addition, Navigant Consulting observed TDSP meter communication testing utilizing a variety of test equipment for a number of advanced meters, as well as the overall recording and storing of test related data.



c) Review of Test Processes

Navigant Consulting reviewed existing advanced meter testing processes and written procedures, including discussions with applicable meter shop personnel to ensure that the necessary processes and control points are in place to provide a basis for consistent and accurate advanced meter accuracy and communications testing. Navigant Consulting also observed the various activities related to advanced meter testing including sample selection, accuracy testing, communications testing, meter shipment quarantine procedures, and overall test acceptance.

Navigant Consulting documented the meter testing activities in the form of process maps that included identification of the various 'control points' employed by the TDSPs to ensure adherence to the testing objectives and written procedures. We evaluated the processes and associated control points to identify any procedural deficiencies that could allow improperly tested advanced meters to be deployed into the field.

d) Review of Historical Test Results from TDSPs and Meter Manufacturers

Navigant Consulting also reviewed the historical advanced meter accuracy test results as supplied by the respective meter manufacturers. Navigant Consulting compared these to the historical advanced meter accuracy test results by the TDSPs during their standardized testing of advanced meters prior to deployment (Sample Testing), as well as test results for advanced meters that were subject to field or meter shop testing post deployment.

2. Advanced Meter Deployment Process and Controls Review

a) Advanced Meter Deployment

Navigant Consulting reviewed the advanced meter deployment activities and written procedures for each TDSP including the process and controls implemented to ensure the proper recording of the final 'out-read' of electromechanical meters being replaced and the proper customer notification after the advanced meter was installed. In addition, Navigant Consulting observed the deployment of nearly 500 advanced meters during the meter change out process pursuant to the independent accuracy testing phase of our work.

b) Review of Advanced Meter Deployment Processes

Navigant Consulting documented the meter deployment activities in the form of a process map which identifies control points employed by the respective TDSPs. Navigant Consulting worked directly with key advanced meter deployment personnel from each TDSP to identify and gather information on advanced meter deployment activities. The information obtained was evaluated relative to the associated control points to identify any process gaps that could affect the proper deployment and installation of advanced meters, or the ability of the advanced meters to effectively establish communications with the TDSP's advanced meter information systems.

c) Review of Advanced Meter Deployment Performance Statistics

Navigant Consulting verified the actual performance of each TDSP's advanced meter deployment process through existing performance reports produced by each TDSP and by collecting and analyzing data samples from various supporting information systems to determine whether each process is producing the expected results.

**C. Observations and Findings**

1. Oncor

a) Advanced Meter Testing Process and Controls Review

*(i) Tour of Meter Shops*

Navigant Consulting visited Oncor's meter shop (, Measurement Services') on two (2) separate occasions. The first visit included meetings with management and operational meter shop personnel, a tour of the meter shop, and a high-level review of the meter testing processes. Navigant Consulting's second visit involved a more detailed review of Oncor's meter shop operations and, in particular, meter testing equipment and testing activities. During this second visit, Navigant Consulting observed advanced meters being Sample Tested, as described further below. Navigant Consulting also reviewed the advanced meter testing equipment records, test records database and Oncor's Meter Equipment Failure Database (, MEFD').

Navigant Consulting found that Oncor's meter testing operations met with the standards of organization, operation and documentation that would be expected of a large TDSP.

*(ii) Observation of Meter Test Equipment Use*

Navigant Consulting observed the WECO test equipment (i.e., , test boards') used to test advanced meter accuracy and Oncor's internally produced advanced meter communication test boards that are used to ensure meters are communicating properly prior to deployment. Oncor's meter testing laboratory, portable field test equipment, meter shop test equipment, instruments, and other necessary equipment conform to the Commission's Substantive Rule §25.124. Oncor calibrates its test equipment every 120 days in accordance with Commission rules.

Navigant Consulting reviewed recent calibration reports and can confirm that Oncor is current with its calibration program and that all test equipment was operational at the time of our visit.

*(iii) Review of Test Processes*

There are several tests that Oncor's advanced meter shipments are subjected to prior to deployment including: 1) First Article Testing, 2) Manufacturer Testing (production ,end-of-line' testing), and 3) Sample Testing. In addition to these tests, Oncor conducts routine testing of meters once they have been deployed in the field. The applicable control points evaluated with respect to the advanced meter test processes include the following:

- 1) **First Article Testing** – Before any new meter type is installed, it must undergo a First Article Test, which is designed to evaluate hardware, firmware, program software, and system interactions to determine that the meter satisfies company specifications. Once a meter type passes First Article Testing, the manufacturer has Oncor’s approval to begin production of the meter. During First Article Testing, the meter is tested to determine its functionality and calibration accuracy through 36 separate test procedures, including Meter Program Verification; Accuracy Test Verification; Register Display Verification; Command Center – On Demand Read; and ETM-Communication through Zigbee to Ember Box. Failure of any of the 36 tests prohibits meter production and requires further discussions and remediation steps between Oncor and the meter manufacturer, Landis+Gyr.
  
- 2) **Manufacturer Testing** – Advanced meters receives function and accuracy tests by Landis+Gyr during the production process in accordance with ANSI standards. Landis+Gyr’s testing equipment features WECO calibration ,test racks', in which meters are mounted and electrical load applied for measurement and recording. Each rack is compared to a master rack once per shift to ensure its accuracy is within specified limits. The master rack and every other calibration rack have their calibration verified once per year at Landis+Gyr’s Reynosa, Mexico manufacturing plant using either Radian Systems RD-21 or an RM-15 test equipment. The RD-21 and RM-15 at Reynosa are calibrated once per year with the RS-703 laboratory system at Landis+Gyr’s Measurement Services laboratory in Lafayette, Indiana. A Calibration Verification / Certification report is issued by this laboratory and kept at Reynosa.
  
- 3) **Verification of Received Meters** – Oncor ensures that the advanced meters it receives have all been tested by Landis+Gyr though a cross check of the manufacturer test reports it receives for each meter. The manufacturer test reports are entered into Oncor’s meter asset registry system called ‘Maximo’ and compared against the shipping documentation and meter serial numbers upon delivery. This ensures that Oncor is receiving the same meters for which it has been supplied manufacturer test reports. Once delivered, the meters remain in quarantine pending completion of Sample Testing, as described below.
  
- 4) **TDSP Sample Testing** – Oncor selects a sample from each shipment of meters from Landis+Gyr for secondary testing at its Lancaster, Texas testing facility. Oncor uses the ANSI Z1.9 statistical sampling method to select a statistically significant sample size of meters to test. The sample size is based on a standard shipment size of 6,912 meters. Oncor randomly selects a pallet of meters from each shipment for testing. Upon receiving the sample pallet, Oncor randomly selects 12 boxes, consisting of 48 meters, from the sample pallet for testing. This sampling methodology ensures that a statistically significant number of meters from each shipment are tested by Oncor.

Each of the meters selected for testing undergoes a functionality test (a 20 point test to check the meter’s ability to connect to the network and transmit data) and a calibration test (a test of each meter’s calibration and accuracy using WECO test boards).

Navigant Consulting reviewed a sample of the Landis+Gyr factory test reports and compared the test reports for a sample of Landis+Gyr advanced meters to corroborate their accuracy. No issues were identified in this review. Navigant Consulting also witnessed the First Article Testing process and compared it to Oncor’s written operating procedures. Navigant Consulting confirmed that the tests as prescribed by Oncor’s procedural documentation are being followed.

Navigant Consulting personnel also witnessed the meter functionality and meter calibration testing processes and compared both to the associated written Oncor Operating Procedures. We confirmed that the tests as prescribed by Oncor’s procedural documentation are being performed as stated. The four (4) control points that ensure quality control for Oncor’s Advanced Meter Testing Process, which are also displayed in *Exhibit 9*, ‘Oncor Advanced Meter Testing Process Map’, are summarized and assessed in the table below.

**Table 6: Oncor Advanced Meter Testing Process Control Points**

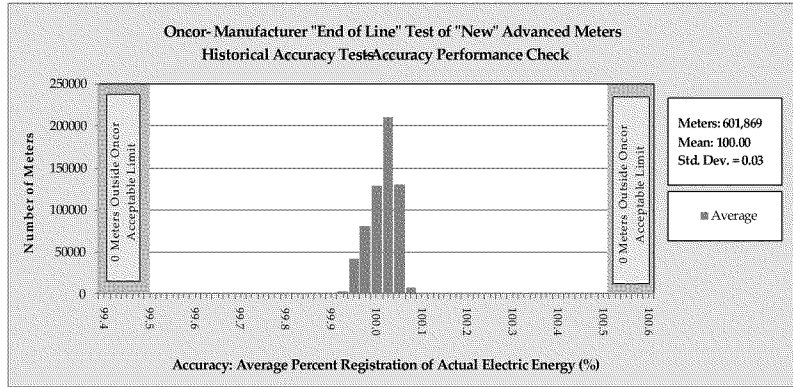
No.	Control Point Owner	Description	Assessment
1.	Oncor	<i>First Article Testing</i> – Oncor tests all pre-production meters for system compatibility.	Control point adequately ensures that hardware and firmware issues are identified and resolved prior to meter types and upgrades being approved for production and use.
2.	Landis+Gyr (production line)	<i>Manufacturer Testing</i> – Landis+Gyr tests all advanced meters before the meters are released from the production line.	Control point adequately verifies the accuracy of advanced meters during manufacturing by testing 100% of all meters prior to release of the lot from production.
3.	Oncor	<i>Verification of Received Meters</i> – Oncor cross references the advanced meter test results received from Landis+Gyr to ensure that all advanced meters have been tested.	Control point adequately verifies that advanced meters received from Landis+Gyr have been tested and that the meter testing history is complete.
4.	Oncor	<i>TDSP Sample Testing</i> – Oncor tests one (1) pallet of advanced meters per shipment. This sample size and testing is based on attributes sampling and is considered statistically significant, and meets or exceeds the ANSI C12 for meter accuracy testing.	Control point adequately verifies the accuracy of advanced meters pre-deployment and meets ANSI standards for statistically significant sample testing.

*(iv) Review of Historical Test Results from TDSP and Meter Manufacturer*

Navigant Consulting reviewed the meter accuracy testing performed by Landis+Gyr and Oncor. The histograms provided below represent the results of the Accuracy Performance Check performed in these processes.

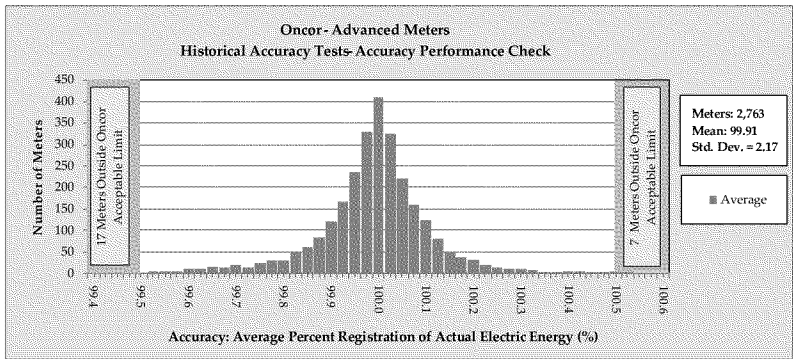
VI. Evaluation of Advanced Meter Deployment

Figure 37 displays a histogram of the meter accuracy testing results performed in a controlled 'testing' environment by Landis+Gyr on advanced meters prior to shipment.



100% of the advanced meters shipped to Oncor were accurate to within +/- 0.2% prior to shipment.

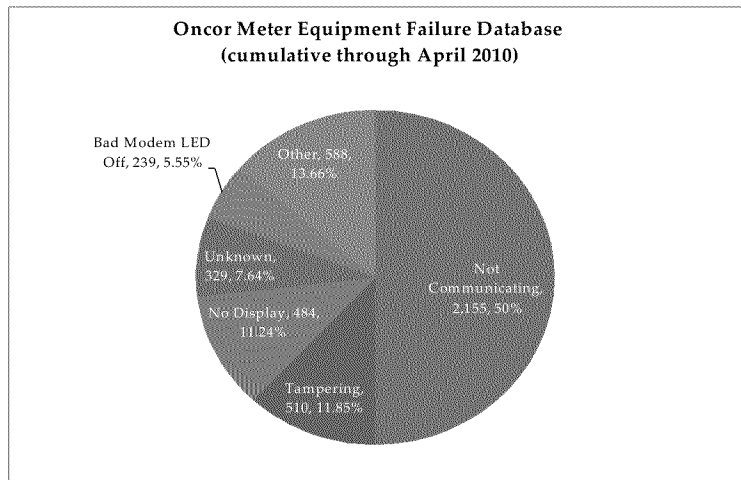
Figure 38 displays a histogram of the meter accuracy testing results performed in a 'field and shop' environment by Oncor on over 2,700 advanced meters tested for various reasons including specific customer requests for meter accuracy testing.



Over 99% of the advanced meters tested by Oncor were found to be accurate to within +/- 0.5%. Of the 24 meters tested outside of that range, 17 tested were still within the Commission's acceptable limits of +/- 2.0%, four (4) had evidence of potential tampering, and four (4) are being reviewed.

Navigant Consulting also reviewed Oncor's Meter Equipment Failure Database (MEFD), which stores information associated with advanced meters that have failed sample or field testing, or been returned to Measurement Services for investigation for suspected failure.

Figure 39 categorizes the meter failures in Oncor's MEFD. Since advanced meter deployment began in 2009, there have been (as of April 2010) a total of 4,305 advanced meter failures, over 85% of which fall into five (5) categories: 1) Meter Not Communicating; 2) Tampering; 3) No Display; 4) Unknown Issues; and 5) Bad Modem LED Off.



Advanced meters returned to Measurement Services for investigation are inspected. Navigant Consulting evaluated the recorded advanced meter failures, the relative timing of the failure, and the identified root cause of the failures, if determined. Advanced meters deemed 'failed' are returned to Landis+Gyr for further investigation and analysis. Upon completion of Landis+Gyr's analysis the advanced meter is repaired or replaced and the analyzed results provided to Oncor.

b) Advanced Meter Deployment Process and Controls Review

(i) *Observation of Advanced Meter Deployment*

As part of the process of removing installed advanced meters in the field and exchanging them with new, independently tested advanced meters, Navigant Consulting personnel witnessed 272 meter exchanges over a 14 day period.

Navigant Consulting confirmed that the meter exchange processes and written procedures established by Oncor are being followed. These procedures are designed to ensure that meters are replaced accurately and safely and that the out-read of the outgoing meter is recorded correctly.

(ii) *Review of Advanced Meter Deployment Processes*

Oncor's advanced meter deployment process has three (3) stages: 1) Pre-installation; 2) Installation; and 3) Post installation. Each is described in more detail below.

- **Pre-installation** – Work orders are created in Oncor's Customer Information System (CIS) and then sent to the mobile workforce management system. The work orders are categorized and prioritized by meter type and route sequence. The trucks are loaded by route at the staging area. The meter installer receives the daily route and verifies that the meters are loaded onto the truck, at which point the meter installation run is started.
- **Installation** – The meter installer goes to the installation location, and then verifies that all information regarding address, premise type, and existing meter is correct before proceeding to install the advanced meter.
- **Post-installation** - The meter installer returns to the staging area and unloads the truck, which may contain removed non-advanced meters and remaining advanced meters not installed. For non-advanced meters, staging area personnel initiate the meter disposal process. For advanced meters, staging area personnel ensure that the count of advanced meters match Maximo, and set up the meters for the following day's installation.

Through a review of Oncor's advanced meter deployment documentation and observation of the actual meter exchanges, Navigant Consulting identified six (6) control points that ensure only tested advanced meters are installed and that these advanced meters are functioning accurately.

- 1) **Work Order Verification** – Once the recently shipped meters are released for installation by Oncor's meter testing shop, Oncor's Measurement Services team verifies that the advanced meter exchange work order contains the serial numbers of advanced meters that

are physically in stock (i.e. have passed sample testing and are no longer in quarantine). The electromechanical meters that will be exchanged are determined by their location and the deployment activities of Oncor’s field personnel.

- 2) **Deployment Schedule Verification** – When the deployment team receives the advanced meter exchange work order from Measurement Services, advanced meters are assigned to an Oncor installation technician, who verifies the advanced meter serial number with the work order before leaving the deployment facility to ensure that the individual advanced meter being installed is from a shipment that has passed Sample Testing.
- 3) **Meter Exchange Verification** – Prior to the physical exchange process, Oncor installation technicians utilize a handheld computer to record the last meter read for the non-advanced meter. A second meter read is taken, along with a digital photograph, when the electromechanical meter returns to the staging area. This ensures that the final read from the outgoing meter is accurate and provides a backup final read.
- 4) **Meter Exchange Exception Review** – At the end of each day, Oncor installation managers review all exceptions generated from meter exchanges for that day and schedule any remediation steps as required.
- 5) **Deployment Schedule Reconciliation** – Oncor reconciles the serial numbers of exchanged meters with deployment schedules to ensure meters were not installed in the wrong place.
- 6) **Communications Monitoring** – Oncor monitors meter communications via an installed route acceptance report which indicates the percentage of advanced meters that are consistently communicating along each advanced meter exchange route. Oncor troubleshoots any advanced meter that fails to consistently communicate until each meter transmits five (5) consecutive register reads to Oncor. Oncor continues to manually read meters on the existing billing cycle until this time, after which the meter ‘cutover’ occurs and the customer starts to be billed based on automatically transmitted meter data.

The six (6) quality control points for the advanced meter deployment process are provided in *Exhibit 10, ‘Oncor Meter Deployment Process Map’*, and summarized and assessed below.

**Table 7: Oncor Advanced Meter Deployment Process Control Points**

No.	Control Point Owner	Description	Assessment
1)	Oncor	<b>Work Order Verification</b> – Oncor verifies that the advanced meter exchange work order contains the serial numbers for meters that are physically in quarantine.	Control point adequately ensures that only tested advanced meter lots are released from quarantine and installed.
2)	Oncor	<b>Deployment Schedule Verification</b> – Oncor verifies that meters on deployment schedules are both meters on the work orders and staged for exchange to ensure only tested advanced meters are installed.	Control point adequately verifies that only tested advanced meter lots are deployed for installation.

VI. Evaluation of Advanced Meter Deployment

3)	Oncor	<b>Meter Exchange Verification</b> – Oncor verifies the final read of the outgoing meter by recording two (2) out-reads and taking a photograph.	Control point adequately verifies that the data from the outgoing meter is accurately recorded to ensure accurate measurement and reporting.
4)	Oncor	<b>Meter Exchange Exception Review</b> – At the end of each work day, Oncor reviews all exceptions generated from meter exchanges for that day to ensure that meter exchange data is accurately captured.	Control point adequately identifies exceptions with newly installed advanced meters and schedules remediation steps.
5)	Oncor	<b>Deployment Schedule Reconciliation</b> – Oncor reconciles the meter serial numbers exchanged that day with the deployment schedule to identify exceptions that require additional clarification.	Control point adequately verifies that the exchanged meters are the meters originally scheduled and ensures that only tested meters are installed.
6)	Oncor	<b>Communications Monitoring</b> – Oncor monitors meter communications via an installed route acceptance report that indicates the percentage of advanced meters communicating along each route.	Control point adequately ensures that only meters consistently reporting data into the network are provisioned.

(iii) Review of Advanced Meter Deployment Process Performance Statistics

As of May 31, 2010, Oncor had deployed 996,151 advanced meters. During the course of this deployment Oncor has exchanged 349 advanced meters (~0.04% of the total advanced meters in service) for various reasons, which are illustrated in **Table 8** below:

**Table 8: Oncor Advanced Meter Installations and Exchanges**

Summary of Advanced Meters Exchanged - Oncor							
Month of Exchange	Total Advanced Meters Installed	Advanced Meters Exchanged by Category					Total
		Failure to Communicate	Meter Hardware	Meter Version Upgrade	Failure to Accept Firmware Upgrade	Other	
10/2008	5,200	-	-	-	-	-	-
11/2008	10,282	-	-	-	-	-	-
12/2008	35,229	-	-	-	-	-	-
1/2009	40,415	1	12	-	-	1	14
2/2009	85,015	-	5	-	-	1	6
3/2009	157,543	-	25	-	-	6	31
4/2009	200,976	-	23	-	-	1	24
5/2009	220,024	-	10	-	-	1	11
6/2009	243,349	2	-	-	-	-	2
7/2009	258,488	1	14	-	-	1	16
8/2009	293,838	12	38	-	-	-	50
9/2009	311,572	6	57	-	-	3	66
10/2009	402,769	9	47	-	-	3	59
11/2009	511,014	-	13	-	-	-	13
12/2009	662,774	2	4	-	-	-	6
1/2010	709,435	2	11	-	-	2	15
2/2010	768,356	1	9	-	-	-	10
3/2010	846,941	1	10	-	-	1	12
4/2010	910,908	-	3	-	-	-	3
5/2010	996,151	-	6	-	-	5	11
<b>Total</b>	<b>996,151</b>	<b>37</b>	<b>287</b>	<b>-</b>	<b>-</b>	<b>25</b>	<b>349</b>



2. CenterPoint

a) Advanced Meter Testing Process and Controls Review

(i) *Tour of Meter Shops*

Navigant Consulting visited CenterPoint's Central Meter Services (, CMS') facility to interview and observe CenterPoint employees execute advanced meter testing on recently received shipments. Navigant Consulting also observed how advanced meters are received and stored to ensure there is no possibility of confusing meters that have been tested with meters that are pending testing. Navigant Consulting observed CenterPoint's practices relating to the management of historical test data and how data is organized in CenterPoint's WECO database for future reference or analysis.

Navigant Consulting found that CenterPoint's meter testing operations met with the standards of organization and operation that would be expected of a large TDSP.

(ii) *Observation of Meter Test Equipment Use*

Navigant Consulting observed the WECO test boards used to test advanced meter accuracy and CenterPoint's internally produced advanced meter communication test boards used to ensure meters are communicating properly prior to deployment. Navigant Consulting also verified the calibration log for the WECO test boards to confirm that the boards have been calibrated at least every 120 days in accordance with Commission rules.

(iii) *Review of Test Processes*

Navigant Consulting reviewed CenterPoint's advanced meter testing process documents and meter testing procedures, and identified six (6) control points that ensure that CenterPoint is deploying only advanced meters that accurately and consistently report electricity usage for each customer.

- 1) ***System Acceptance Testing*** – Before CenterPoint deploys any advanced meter with a new release of hardware, firmware, operating software, or software patches, CenterPoint personnel work with the meter manufacturer, Itron, to define the system acceptance testing that Itron will perform on the new release. CenterPoint subsequently develops a series of System Acceptance Tests to test the actions that the advanced meters will be required to perform when deployed in the field. Any unexpected results from the Systems Acceptance Testing are recorded and investigated for corrective action with Itron. Throughout this process, Itron and CenterPoint work closely together to ensure that all functions that the advanced meter hardware/firmware/software combination are expected to perform can be accurately and consistently performed during the Systems Acceptance Testing. CenterPoint will not deploy any changes until their advanced meters pass the System Acceptance Tests.
- 2) ***Manufacturer Production Line Testing*** – Every advanced meter also receives a complete function and accuracy test by Itron during the production process.

- 3) **Manufacturer Sample Testing** – Prior to shipping, Itron uses the ANSI Z1.9 statistical sampling method to select a statistically significant sample size of meters to test for accuracy. After the advanced meters have passed both production line and sample testing, Itron will ship the advanced meters to North Houston Pole Line ( , NHPL ' ), an independent contractor responsible for deploying the advanced meters.
- 4) **Verification of Received Meters** – The advanced meter serial numbers that are received from Itron are verified with the notice of shipment (NOS) documentation to ensure the advanced meters received are the same meters tested by Itron. Once CenterPoint verifies that the received lot and the NOS serial numbers match, the advanced meters are quarantined for further testing.
- 5) **TDSP Sample Testing** – CenterPoint randomly selects a sample of advanced meters using an internal , Bar X ' method, which meets ANSI Z1.9 standards, to test a statistically significant sample of advanced meters for accuracy. Only after 100% of the sampled meters have passed CenterPoint’s accuracy test will the entire batch of meters be released from quarantine.
- 6) **Pre-Release Sample Checks** – CenterPoint physically verifies samples of tested advanced meter serial numbers against the NOS serial numbers prior to being released from quarantine. Once verified by CenterPoint, the advanced meter lot is released from quarantine for installation by NHPL based on work order requests from CenterPoint.

Through our evaluation of CenterPoint and Itron’s advanced meter testing process and control points, Navigant Consulting confirmed that advanced meters are tested in a manner that should effectively mitigate the risk of a meter that does not meet CenterPoint’s performance specifications being installed in the field. The six (6) quality control points for the advanced meter testing process are provided in *Exhibit 11*, , CenterPoint Meter Testing Process Map ' and summarized and assessed in the table below.

**Table 9: CenterPoint Meter Testing Process Control Points**

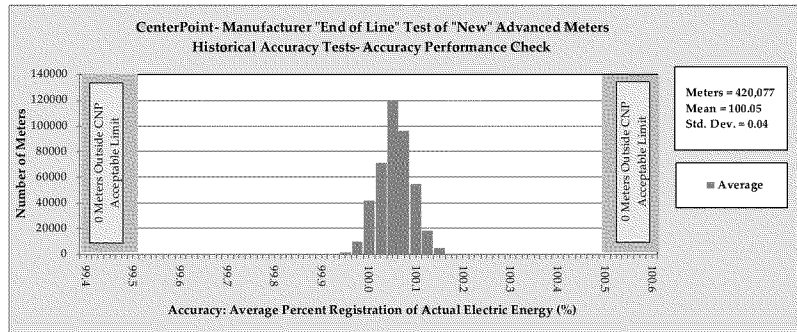
No.	Control Point Owner	Description	Assessment
1)	CenterPoint	<b>System Acceptance Testing</b> – CenterPoint conducts system acceptance testing of all new advanced meter hardware, firmware, operating system software, and software updates.	Control point adequately ensures that hardware and firmware issues are identified and resolved prior to meter types and upgrades being approved for production and use.
2)	Itron	<b>Manufacturer Production Line Testing</b> – Itron tests all advanced meters before the meters are released from the production line.	Control point adequately verifies the accuracy of advanced meters during manufacturing by testing 100% of all meters prior to release of the lot from the production.
3)	Itron	<b>Manufacturer Sample Testing</b> – Itron tests one (1) sample lot of advanced meters for each shipment. The sample size meets	Control point adequately verifies the accuracy of advanced meters during post-production and meets the ANSI

		ANSI Z1.9 standards. The shipment of advanced meters remains quarantined until accuracy testing is complete and meters are released for shipment to CNP.	standards for statistically significant sample testing.
4)	CenterPoint	<b>Verification of Received Meters</b> – CenterPoint verifies the advanced meter serial numbers received from Itron match the NOS to ensure the advanced meters received are the same as those tested.	Control point adequately verifies that advanced meters received from Itron have been tested.
5)	CenterPoint	<b>TDSP Sample Testing</b> – CenterPoint selects a sample from each shipment and tests according to the ANSI standards for accuracy. The entire shipment remains quarantined until testing is complete.	Control point adequately verifies the accuracy of advanced meters pre-deployment and meets ANSI standards for statistically significant sample testing.
6)	CenterPoint	<b>Pre-Release Sample Checks</b> – CenterPoint physically spot-checks the Bar-X tested advanced meter serial numbers against the NOS prior to release from quarantine.	Control point adequately verifies that only tested advanced meter lots are released from quarantine and deployed.

(iv) Review of Historical Test Results from TDSP and Meter Manufacturer

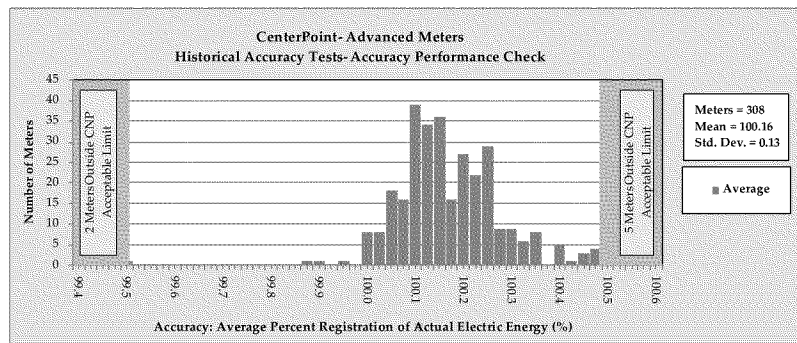
Navigant Consulting reviewed advanced meter testing conducted by Itron and CenterPoint during the processes described above. The histograms below display similar results with a difference in average accuracy of approximately 0.11%.

Figure 40 displays a histogram of the meter accuracy testing results performed in a controlled ‘testing’ environment by Itron on advanced meters prior to shipment.



100% of the advanced meters shipped to CenterPoint were accurate to +/- 0.5% prior to shipment.

Figure 41 displays a histogram of the meter accuracy testing results performed in a ‘field and shop’ environment by CenterPoint on over 300 advanced meters tested for various reasons including specific customer requests for meter accuracy testing.



*Over 99% of the advanced meters tested by CenterPoint were found to be accurate within +/- 0.5%, and all were accurate by ANSI standards. The seven (7) meters that tested outside of the range were a result of technicians utilizing a less sophisticated and precise field testing technique that is believed to account for some of the minor variations observed in the accuracy test results. The seven (7) meters that tested outside of +/- 0.5% were still within the acceptable limits of +/- 2.0%.*

CenterPoint stated that as of May 31, 2010, no advanced meters have failed their ,Bar-X' accuracy performance or network communications test.

b) Advanced Meter Deployment Process and Controls Review

(i) *Observation of Advanced Meter Deployment*

Itron maintains responsibility for the advanced meters shipped to CenterPoint until they are deemed ,accepted and approved' by CenterPoint.<sup>56</sup> CenterPoint takes responsibility at that time and also has responsibility for the deployment of advanced meters into new premises (i.e., ,growth areas') that were constructed after the advanced meter deployment began and are receiving a meter for the first time. Itron utilizes NHPL to conduct advanced meter installation, as well as manage the logistics of receiving advanced meters from the Itron factory and disposing of the removed electromechanical meters.

As part of our investigation, Navigant Consulting implemented a non-standard exchange of independently-tested new advanced meters with advanced meters that had already been deployed in the field. Navigant Consulting personnel witnessed 160 meter exchanges over a one (1) day period.

In accompanying NHPL personnel, Navigant Consulting confirmed that the written meter exchange procedures established by CenterPoint's management and as defined in the Scope of Services agreement between CenterPoint and Itron are being followed. These procedures are designed to ensure that advanced meters are deployed accurately and safely and that the out-read of the outgoing meter is recorded accurately for accurate billing during the transition from the electromechanical meter to the advanced meter.

(ii) *Review of Advanced Meter Deployment Processes*

Through a review of CenterPoint's advanced meter deployment documents and observation of employee execution of the written procedures during the actual meter exchange, Navigant Consulting identified seven (7) control points that ensure only tested advanced meters are installed and that these meters are functioning accurately.

- 1) **Route Exception Report** – Once the advanced meters are released for installation by CenterPoint's meter testing shop, NHPL verifies that no electromechanical meters have already been exchanged for an advanced meter on that route prior to assigning the work

<sup>56</sup> ,Accepted and approved' occurs once the advanced meters are fully functional for a specified geographic area (an existing meter reading route) in CenterPoint's service territory.

orders to their technicians. The electromechanical meters scheduled for exchange are determined based on existing manual meter reading routes. Manual meter reads are used as a verification measure for advanced meters after installation and designated as , AMR ready' by CenterPoint. CenterPoint designs the advanced meter exchange schedule so that electromechanical meters are not exchanged during normally scheduled manual meter reading cycles, which could affect customer bill calculations.

- 2) ***Advanced Meter Installation Checklist*** – Prior to and during the actual meter exchange, NHPL performs its own internal verification process to ensure that the pre-selected advanced meters are installed. The first step in the verification process occurs when work orders are assigned to a NHPL installation technician, who verifies that the advanced meters are from a tested lot of meters. The next verification step occurs when NHPL's installation technician utilizes a handheld computer to record the last meter read and serial number from the outgoing electromechanical meter, as well as takes a digital photograph of the meter for confirmation. A second digital photograph of the electromechanical meter is taken when it is returned to the NHPL warehouse by NHPL technicians as a backup , final read.'
- 3) ***Meters Not Exchanged List*** – Itron generates an installation report for the total number of advanced meters that were installed the prior day. CenterPoint uses the report to verify that the total number of meters installed equals the number of new meters entered into CenterPoint's CIS for that day. CenterPoint and Itron manually reconcile any discrepancies identified during this process.
- 4) ***Mass Meter Exchange Exception*** – CenterPoint manually reconciles an automatically generated meter exchange exceptions report to correct any meter serial and customer account discrepancies that resulted from the meter exchange. CenterPoint internally corrects discrepancies and verifies discrepancies with Itron as needed to ensure that the MDMS and CIS are correctly updated with meter and customer account information.
- 5) ***Meter Route Consumption Report*** – CenterPoint and Itron monitor a shared , installed route acceptance report', which indicates the percentage of advanced meters that are consistently communicating along each advanced meter exchange route.<sup>57</sup> The route acceptance report begins functioning after the advanced meter is exchanged, fully functional in the DCE and MDMS, and is deemed , AMR Ready' by CenterPoint. When an advanced meter achieves , AMR ready' status, usage data automatically received from the meter can be used for billing calculations. However, CenterPoint continues to manually read all advanced meters during this time frame to provide an additional data source for verification in case of billing issues arise following installation of the advanced meter and the meter's designation as , AMR ready.'

<sup>57</sup> Consistent and accurate reporting is defined as 99% of all meters on a existing route communicating consistently and providing accurate usage data.

- 6) **Meter Route Approval** – Once 99% of the meters on a specified route communicate consistently, CenterPoint accepts the advanced meters on that route as fully functional (i.e., 'provisioned'), designates the route as 'accepted and approved' and takes responsibility for monitoring and repairing the advanced meters.<sup>58</sup> CenterPoint also stops manually reading these meters and performs a final verification to ensure that the advanced meters are resident in their advanced meter data systems.
  
- 7) **"Accepted and Approved" Reconciliation** – A CenterPoint analyst manually reconciles all approval data in the CIS to ensure that the advanced meter status has been changed to 'accepted and approved' in the CIS, at which point manual meter reads are no longer used to verify advanced meter data.

The seven (7) quality control points for the advanced meter deployment process are provided in *Exhibit 12*, 'CenterPoint Meter Deployment Process Map', and summarized and assessed in the table below.

**Table 10: CenterPoint Advanced Meter Deployment Process Control Points**

No.	Control Point Owner	Description	Assessment
1)	Itron/NHPL	<b>Route Exception Report</b> – An Itron/NHPL exception report is generated and reconciled if an advanced meter installation work order has a premise that already has an advanced meter.	Control point adequately ensures that advanced meter exchanges take place only at premises that have not received an advanced meter.
2)	Itron/ NHPL	<b>Advanced Meter Installation Checklist</b> – NHPL conducts multiple verification steps to ensure that only tested advance meters are deployed and that all critical information from the electromechanical meter is recorded.	Control point adequately verifies that advanced meters used for exchange are tested and final reads from the outgoing electromechanical meters are captured for accurate customer billing.
3)	CenterPoint	<b>Meters Not Exchanged List</b> – NHPL creates a list of the total number of installations, which is reconciled with the CIS to ensure that the total number of meters installed equals the total number of meters in the CIS.	Control point adequately verifies that the advanced meters NHPL reports as installed equals the number of new advanced meters recognized by CenterPoint's CIS.
4)	CenterPoint/ Itron/ NHPL	<b>Mass Meter Exchange Exception</b> – An automated is manually reconciled by CenterPoint and Itron ensures that the CIS & MDMS are updated.	Control point adequately ensures that newly installed advanced meters are input into the CIS and MDMS.
5)	CenterPoint/ Itron	<b>Meter Route Consumption Report</b> – Automated reports generated and reviewed by CNP and Itron to ensure	Control point adequately verifies that 99% of advanced meters in a specific geographical area are

<sup>58</sup> Also known as 'Settlement Provisioned' which is an advanced meter as defined in P.U.C. SUBST. R. 25.130, Advanced Metering, that has been deployed by the Company, and for which 15-minute interval data is sent to and accepted by ERCOT for settlement purposes.

VI. Evaluation of Advanced Meter Deployment

		advanced meters are accurately and consistently reporting information along the existing meter routes.	reporting accurate and consistent information before manual meter readings are discontinued.
6)	CenterPoint	<i>Meter Route Approval</i> – CenterPoint approves a meter exchange route and verifies that advanced meters are resident in the applicable data systems.	Ensures that meters are , accepted and approved ‘ in all data systems; required for meter status to be changed to accepted and approved.
7)	CenterPoint	<b>“Accepted and Approved” Reconciliation</b> – Route approval data in the CIS is manually reconciled after the advanced meter status is updated to , Accepted and Approved ‘ in the CIS, at which point manual meter reads are no longer necessary.	Control point adequately verifies that mode flag is changed so that the meter is , accepted and approved ‘ and manual meter reads are ended.

(iii) Review of Advanced Meter Deployment Process Performance Statistics

As of May 31, 2010, CenterPoint has deployed 397,136 advanced meters over a 14 month period. CenterPoint began its deployment using Itron hardware version 1.5 advanced meters and transitioned to the hardware version 2.0 advanced meters in August of 2009 after it became available and was approved for deployment through CenterPoint’s System Acceptance Testing. During the course of this deployment CenterPoint has exchanged 14,718 advanced meters (or ~ 3.7% of the total advanced meters deployed) for assorted reasons. **Table 11** provides additional detail related to CenterPoint’s advanced meter installations and exchanges.<sup>59</sup>

**Table 11: CenterPoint Advanced Meter Installations and Exchanges**

Summary of Advanced Meters Exchanged - CenterPoint							
Month of Exchange	Total Advanced Meters Installed	Advanced Meters Exchanged by Category					Total
		Failure to Communicate	Meter Hardware	Meter Version Upgrade	Failure to Accept Firmware Upgrade	Other	
4/2009	10,251	-	3	143	-	-	146
5/2009	20,569	-	-	-	-	-	-
6/2009	31,478	-	-	-	-	-	-
7/2009	47,106	-	-	-	-	-	-
8/2009	69,240	32	12	161	-	-	205
9/2009	90,933	-	-	-	-	-	-
10/2009	113,066	16	-	-	-	-	16
11/2009	134,009	-	-	-	-	-	-
12/2009	152,275	-	-	-	-	-	-
1/2010	195,090	3,002	-	-	-	-	3,002
2/2010	247,370	228	-	-	20	-	248
3/2010	289,093	235	-	-	-	10,453	10,688
4/2010	341,779	43	-	-	-	111	154
5/2010	397,136	167	-	-	-	92	259
<b>Total</b>	<b>397,136</b>	<b>3,723</b>	<b>15</b>	<b>304</b>	<b>20</b>	<b>10,656</b>	<b>14,718</b>

<sup>59</sup> All advanced meters exchanged by CenterPoint have been under warranty.

The largest category of CenterPoint's meter exchanges (10,656 meters or 2.7% of advanced meters installed) were the result of a 'load profile saturation' issue, which was reported to the Commission in CenterPoint's February 28, 2010 Status Report and is further discussed in Section X of this report. This issue was detected by CenterPoint through one of its existing Meter Data Management process controls.

3. AEP Texas

a) TDSP Advanced Meter Testing Process and Controls Review

(i) *Tour of Meter Shops*

Navigant Consulting visited AEP Texas' meter test shop to interview and observe AEP Texas employees execute both meter accuracy and communication testing on advanced meters from recently received shipments. As part of this observation, Navigant Consulting also observed how the advanced meters are received and the actual storage area where they are quarantined to ensure advanced meter lots that have been tested are not confused with meters that are pending testing. Navigant Consulting observed the processes AEP Texas follows relating to retention of historical testing data on advanced meters and how the data is organized in AEP Texas' Marketing, Accounting and Customer Service System (, MACSS') for future reference or analysis.

Navigant Consulting found that AEP Texas' meter testing operations met with the standards of organization, operation and documentation that would be expected of a large TDSP.

(ii) *Observation of Meter Test Equipment Use*

As part of the AEP Texas meter shop tour, Navigant Consulting observed the WECO test boards used to test advanced meter accuracy and AEP Texas' internally produced advanced meter communication test boards used to ensure meters are communicating properly before deployment. Navigant Consulting also reviewed the calibration log for the WECO test boards to confirm that the boards were calibrated at least every 120 days in accordance with Commission rules.

(iii) *Review of Test Processes*

Navigant Consulting reviewed AEP Texas' written procedures for meter testing (which are organized and clearly documented in the form of a single handbook), and conducted interviews with AEP Texas meter testing personnel to identify four (4) control points that AEP Texas employs to ensure meters operate to ANSI accuracy standards prior to being installed.

- 1) ***System Acceptance Testing*** - Before AEP Texas deploys any advance meter with a new release of hardware, firmware, operating software, or software patches, AEP Texas will work with the meter manufacturer, Landis+Gyr, to identify the system testing to perform on the new release. AEP Texas subsequently develops a series of System Acceptance Tests to test the functions the advanced meters will be required to perform when deployed. Any unexpected results are recorded and investigated for corrective action with Landis+Gyr. Throughout this process, AEP Texas and Landis+Gyr work closely to



ensure that all functions of the advanced meter hardware/firmware/software combination can be accurately and consistently performed. AEP Texas will not deploy any changes until their advanced meters pass the System Acceptance Tests.

- 2) **Manufacturer Testing** – Advanced meters receive function and accuracy tests by Landis+Gyr during the production process.
- 3) **Manufacturer Sample Testing** – Prior to shipping, Landis+Gyr uses the ANSI Z1.9 statistical sampling method to select a statistically significant sample size of meters to test for accuracy. After the meters have passed these two (2) separate series of tests, Landis+Gyr will ship the advanced meters to the warehouse of SCOPE Services, AEP Texas’ independent contractor responsible for installation of advanced meters. Once received and processed by SCOPE, the new shipment of advanced meters is quarantined in a segregated area of SCOPE’s facility. The sample that AEP Texas will test is segregated by SCOPE and shipped to AEP Texas’ meter shop in Corpus Christi, Texas.
- 4) **Validation of Received Meters** – The advanced meter serial numbers that are received from Landis+Gyr are verified with the notice of shipment (NOS) file sent to AEP Texas’ data center in Columbus, Ohio to ensure the advanced meters that were received are the same ones tested by Landis+Gyr. Once the serial numbers and the NOS are compared and matched, the sample set of advanced meters from the new shipment begin testing.
- 5) **TDSP Meter Testing** – AEP Texas’ meter shop verifies that the advanced meters have the correct software package loaded. Meters are then tested by AEP Texas using an internal , Bar X’ method to test a statistically significant sample of advanced meters for accuracy. Only after 100% of the randomly selected meters have passed accuracy and communications tests and AEP Texas has verified that the scoring and quantity of meters tested meets their minimum threshold for accuracy and statistical significance ( , Sigma’ test) will the advanced meters be released from quarantine for deployment by SCOPE.

Through our review of AEP Texas’ and Landis+Gyr’s advanced meter testing process and control points, Navigant Consulting confirmed that advanced meters are being tested in a manner that should mitigate the risk of meters that do not meet AEP Texas’ accuracy standards being deployed.

The five (5) quality control points for the AEP Texas advanced meter testing process are provided in **Exhibit 13**, “AEP Texas Meter Testing Process Map”, and summarized and assessed below:

**Table 12: AEP Texas Advanced Meter Testing Process Control Points**

No.	Control Point Number	Description	Assessment
1)	AEP (Columbus & Texas)	<b>System Acceptance Testing</b> – AEP conducts system acceptance testing of all new advanced meter hardware, firmware, operating system software, and software updates.	Control point adequately verifies the usage reporting, communications, and system compatibility of meters prior to production and deployment.

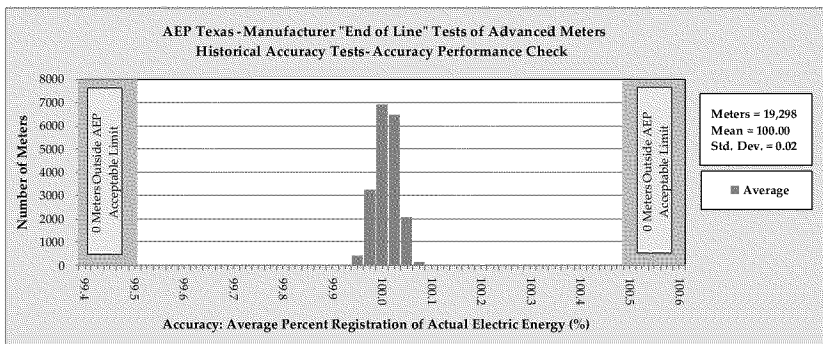
VI. Evaluation of Advanced Meter Deployment

2)	Landis+Gyr (production line)	<b>Manufacturer Testing</b> – Landis+Gyr tests all advanced meters before the meters are released from the production line.	Control point adequately verifies the accuracy of advanced meters during manufacturing by testing 100% of all meters prior to release of the lot from production.
3)	Landis+Gyr	<b>Manufacturer Sample Testing</b> – Landis+Gyr tests one (1) sample lot of advanced meters from each shipment. The sample size conforms to ANSI Z1.9 sample standards. The shipment of advanced meters remains quarantined at the factory until accuracy testing is complete and the meters are released to AEP Texas’ independent contractor SCOPE.	Control point adequately verifies the accuracy of advanced meters during post-production and meets the ANSI standards for statistically significant sample testing.
4)	AEP (Columbus & Texas)	<b>Validation of Received Meters</b> – AEP Columbus and Texas compare the advanced meter test results received from Landis+Gyr in the NOS with the advanced meter shipment received by SCOPE to ensure that all advanced meters have been tested.	Control point adequately verifies that advanced meters received by AEP Texas have been tested by the manufacturer and documented.
5)	AEP Texas	<b>TDSP Meter Testing</b> – AEP Texas ensures the advanced meters have the correct software and tests one (1) pallet per shipment. The sample size meets the ANSI Z1.9 standard for sample size for meter accuracy testing.	Control point adequately verifies the accuracy and communication of advanced meters and meets ANSI standards for statistically significant sample testing.

(iv) Review of Historical Test Results from TDSP and Meter Manufacturer

Navigant Consulting reviewed the advanced meter testing conducted by Landis+Gyr. Given AEP Texas’ limited deployment, AEP Texas has tested only 56 meters for accuracy at this point. AEP Texas further informed Navigant Consulting that as of May 31, 2010, no advanced meters have failed accuracy tests.

Figure 42 displays a histogram of the meter accuracy testing results performed by Landis+Gyr on advanced meters prior to shipment of the advanced meters to AEP Texas.



**100% of the advanced meters shipped to AEP Texas were accurate to within +/- 0.5% prior to shipment.**

b) Advanced Meter Deployment Process and Controls Review

(i) *Observation of Advanced Meter Deployment*

Navigant Consulting personnel witnessed 64 advanced meter exchanges over two (2) separate one (1) day periods. 32 advanced meter exchanges were observed during the normal electromechanical to advanced meter exchange, and an additional 32 advanced meter exchanges were observed in the exchange of advanced meters in the field with new independently-tested advanced meters.

In accompanying AEP Texas personnel on these meter exchanges Navigant Consulting was able to confirm that the written meter exchange procedures established by AEP Texas' management are being followed. These procedures are designed to ensure that meters are replaced accurately and safely and that the 'out-read' of the outgoing meter is recorded accurately.

(ii) *Review of Advanced Meter Deployment Processes*

Through a review of AEP Texas' advanced meter deployment documentation and meter exchange procedures, Navigant Consulting identified six (6) control points that ensure only tested advanced meters are installed and that these advanced meters are functioning accurately.

- 1) ***Billing Cycle Verification*** – Once the advanced meters have passed all required tests and are released for installation by AEP Texas' meter shop, AEP Texas' Retail Meter Revenue Operations group receives advanced meter exchange requests from SCOPE and issues work orders that have been screened for meter reading dates. AEP Texas verifies that these dates are within plus or minus four (4) days from the normally scheduled manual meter read for that premise to ensure that the meter exchange will not interfere with the existing bill calculation process. AEP Texas will continue to use manual meter reads for advanced meters until August 2010. As such, this control point is in place to reduce the possibility of the advanced meter exchange affecting a customer's normal bill calculation.
- 2) ***Advanced Meter Installation Checklist*** – Once SCOPE has assigned the advanced meters to an installation technician, SCOPE stages advanced meters from the tested meter storage area of their facility and verifies that the handheld installation computers are synchronized with correct premise information before leaving the deployment facility. SCOPE installation technicians utilize their handheld installation computer to record the last meter read for the non-advanced meter three (3) separate times to ensure out-read accuracy. The technician then takes a digital photograph of the electromechanical meter as a 'final read' verification source in case exceptions need to be reconciled later.
- 3) ***Meter Exchange Exception Review*** – At the end of each work day, SCOPE's advanced meter exchange project manager reviews all exceptions generated from meter exchanges for that day to ensure that critical advanced meter exchange data is accurately captured. SCOPE has 24 hours to reconcile any meter exchange exceptions before updating AEP Texas with the advanced meter serial numbers that were installed. The 24 hour period allows time to reconcile installation exceptions before AEP Texas uploads the new advanced meters into its CIS.

- 4) **Exchanged Meter Verification** – After SCOPE notifies AEP Texas that SCOPE met its meter access and route saturation commitments for a given meter exchange route, AEP Texas verifies that all advanced meters along that route are communicating through the AMS network. AEP Texas spot checks different premises to ensure proper installation of advanced meters and produces a listing of advanced meter discrepancies for review and correction by SCOPE.
- 5) **Exchanged Meter Investigations** – SCOPE will investigate premises with identified advanced meter issues and correct any problem found during the investigation described in Control Point 4 prior to AEP Texas accepting the exchanged meter route. SCOPE will submit a follow up report with actions taken to AEP Texas once SCOPE has corrected the discrepancies.
- 6) **Exchanged Meter Acceptance Review** – Upon verification that all discrepancies have been corrected, AEP Texas accepts the advanced meters on that route and becomes solely responsible for the support of those meters. As of July 2010, AEP Texas continues to use manual meter reads as the primary data source for recording electricity usage from both electro-mechanical and advanced meters. AEP Texas plans to transition to completely automated reads from advanced meters beginning in August 2010.

Through our review of AEP Texas and SCOPE’s advanced meter deployment processes and control points, Navigant Consulting confirmed that advanced meters are being deployed in line with documented processes and in accordance with good industry practices.

The six (6) quality control points for the AEP Texas advanced meter deployment process are provided in *Exhibit 14*, ‘AEP Texas Meter Deployment Process Map’, are summarized and assessed in the below table:

**Table 13: AEP Texas Advanced Meter Deployment Process Control Points**

No.	Control Point Owner	Description	Assessment
1)	AEP Texas	<b>Billing Cycle Verification</b> – AEP Texas generates advanced meter exchange work orders for meters that are not in +/- four (4) days of a manual meter reading cycle.	Control point adequately ensures that only tested advanced meters will be exchanged without affecting customers’ normal bill calculation process.
2)	SCOPE	<b>Advanced Meter Installation Checklist</b> – SCOPE conducts multiple verification steps to ensure that only tested advance meters are deployed and that all critical information from the electromechanical meter is recorded.	Control point adequately ensures that advanced meters used for exchange are tested and that the last read from the outgoing electromechanical meter is accurately captured for customer billing during the transition to the newly installed advance meter.
3)	SCOPE	<b>Meter Exchange Exception Review</b> – At the end of each work day, SCOPE’s advanced meter exchange project	Control point adequately validates that any identified exceptions are addressed.

VI. Evaluation of Advanced Meter Deployment

		manager reviews all exceptions generated from meter exchanges for that day to ensure that meter exchange data is accurately captured.	
4)	AEP Texas	<b>Exchanged Meter Verification</b> – Within three (3) business days of receiving a route saturation report from SCOPE, AEP Texas will confirm that installed Meters are reporting via AMS and produce a listing of non-responding meters for follow-up.	Control point adequately ensures that newly installed advanced meters are consistently communicating with the AMS network.
5)	SCOPE	<b>Exchanged Meter Investigations</b> – For advanced meters not communicating with the AMS system or with other issues identified during AEP’s spot checks, SCOPE will investigate these exceptions and correct any problems.	Control point adequately ensures that the new exchanged advanced meters are communicating with the AMS network and correctly installed.
6)	AEP Texas	<b>Exchanged Meter Acceptance Review</b> – AEP Texas will accept routes once audited advanced meters are confirmed to be correctly installed.	Control point adequately ensures that advanced meters are correctly installed and consistently communicating with the AMS network.

*(iii) Review of Advanced Meter Deployment Process Performance Statistics*

As of May 31, 2010, AEP Texas had deployed 9,272 Landis+Gyr Focus AXSD advanced meters over a seven (7) month period, with a gap in deployment due to Systems Acceptance Testing. During the course of this deployment AEP Texas has not removed or exchanged any advanced meters from service for accuracy issues. Advanced meters have been removed by AEP Texas pursuant to part of our investigation and for standard operational reasons.

**VII. Customer Electric Usage / Billing Analysis**

**A. Background**

In addition to conducting independent testing of the accuracy of advanced meters and evaluating the advanced meter deployment and provisioning processes by the respective TDSPs, Navigant Consulting also analyzed whether there were any significant differences in the average usage of electricity by customers with advanced meters relative to customers with older electromechanical meters – differences that could be attributed to the advanced meters themselves.

**B. Customer Billing Procedures**

TDSPs such as Oncor, CenterPoint and AEP Texas own, operate, and maintain the electrical network infrastructure (i.e., the wires and poles) that transmit and distribute electricity to consumers in their service territories. While TDSPs are required to install and maintain electric meters to measure electricity usage, customers actually receive their bills from REPs.

Basic metering systems typically consist of the same types of major components: electric meters, a data collection system, data storage, and data analysis and presentation. Whether the meter is read manually each month by a meter reader (e.g., electromechanical meters) or collected electronically via wireless communication (e.g., advanced meters), the TDSPs are responsible for collecting information from electric meters, storing that information in a database for further processing and analysis, and then presenting the information in an easily interpreted form to ERCOT and to REPs.

**C. Scope of Work**

Navigant Consulting performed statistical analysis on the residential electric power use (i.e., kWh electric usage) history of a random sample of customers with advanced meters in comparison to a random sample of customers that still had electromechanical meters. The objective of Navigant Consulting’s analysis of the electricity consumption history of customers with advanced meters was to statistically evaluate whether customers with advanced meters experienced different (i.e., higher) metered electricity usage than they would have otherwise experienced without the advanced meter (i.e., whether advanced meters have or are affecting recorded kWh consumption). The analysis performed examined whether the installation of advanced meters had an impact on the amount of electricity measured and recorded for customers with advanced meters, including an evaluation of unexpected variances, anomalies and/or inconsistencies.

The statistical analysis of historical electric usage observes any changes in electricity consumption prior to and following installation of advanced meters and compares them to power consumption changes over the same period experienced by customers not receiving advanced meters (i.e., customers with older electromechanical meters). Significant differences between these two groups over the same time period were analyzed (i.e., regressed) against potential explanatory variables such as heating degree days and cooling degree days, and presence of an advanced meter or electromechanical meter, as well as differences in heating source (i.e., gas vs. electric), structure

type (i.e., apartments vs. single-family homes), among others, as necessary, to determine if the installation of an advanced meter had any relative impact.

Navigant Consulting's analysis of historical electricity usage by residential customers with advanced and electromechanical meters focused on the electric usage measured and recorded by the TDSP in the form of kilowatt hours (kWh) for each customer, which is ultimately provided to ERCOT and the REPs. However, given that AEP Texas had only recently begun its deployment of advanced meters, including approval and acceptance of advanced meter automated reads for use in customer billing, the statistical analysis referenced throughout this section of the Report relates to Oncor and CenterPoint, respectively.

Navigant Consulting's analysis centered on comparisons between two groups of customers with advanced meters and customers with electromechanical meters described below:

- A randomly selected sample of residential customers (i.e., meter premises) with advanced meters compared to a ,matched' sample of residential customers (i.e., meter premises) with electromechanical meters; and
- All residential customers with advanced meters provisioned and accepted for use compared to all residential customers (in the same or a contiguous area) with electromechanical meters.

**D. Work Performed**

The statistical analysis of historical customer electric usage included the following steps:

- 1) Identification of the relevant population of advanced and electromechanical meters to include in the analysis;
- 2) Request, review and standardization of customer electric usage history for the relevant population of advanced and electromechanical meters;
- 3) Selection of a random sample of advanced meters for analysis and a ,matched' control group or sample of electromechanical meters to provide a baseline for comparison;
- 4) Assessment of the effect of weather, as well as other variables, on actual and expected electricity usage in the applicable service territories;
- 5) Assessment of the impact of advanced meters, if any, on differences in the average metered monthly electricity consumption between the random sample of advanced meters and the ,matched' control sample of electromechanical meters;
- 6) Assessment of the impact of advanced meters, if any, on differences in the average metered monthly electricity consumption for the total relevant population of advanced meters in comparison to the relevant population of electromechanical meters; and
- 7) Assessment of the impact of advanced meters, if any, on the distribution of metered monthly electricity consumption for the total relevant population of meters.

Each of the work steps performed by Navigant Consulting is further described below:

1. Identification of Advanced and Electromechanical Meter Population

Navigant Consulting requested a listing of all residential advanced meters that had been deployed, as well as provisioned and approved for use, by Oncor and CenterPoint at the start of our investigation. In addition, only customers with electromechanical meters in areas (i.e., zip codes) where advanced meters had been deployed, as well as in zip codes contiguous to those areas, were considered in this analysis. Oncor and CenterPoint provided information for the following numbers of advanced meters and electromechanical meters in use as of March, 2010 in *Table 14* below:

TDSP	Advanced Meters in Use as of March 2010		Electromechanical Meters in Use as of March 2010		Total
	Number	% of Total	Number	% of Total	
Oncor	602,185	60.7%	389,962	39.3%	992,147
CenterPoint	245,892	28.1%	630,605	71.9%	876,497
<b>Total</b>	<b>848,077</b>	<b>45.4%</b>	<b>1,020,567</b>	<b>54.6%</b>	<b>1,868,644</b>

The information provided by Oncor and CenterPoint contained a listing of the representative meters along with other attributes relevant to our consideration of the meters and their applicability to our analysis. Some of the criteria utilized in identifying a homogenous population of residential meters for sampling and statistical analysis included the following:

- Form 2S, Class 200 residential advanced and electromechanical meters;
- Meters meeting consistent meter type and code guidelines relative to the same manufacturer, number of dials, phase, volts, amp, and kWh and kVa amplifiers, etc.;
- Meters that had been provisioned and otherwise approved for use;
- Meters currently in use with an 'active' account status; and
- Meters under an applicable residential rate plan, among others.

The meters selected for sampling consisted of a homogeneous group of meters designed to meet the targets for statistical significance and testing criteria defined pursuant to the scope of work.

2. Request for Customer Electric Usage / Consumption Data

Upon identification of the population of advanced meters, and appropriate sub-population of electromechanical meters in the same or contiguous zip codes, Navigant Consulting requested historical customer consumption (i.e., electric usage) information for the June 2006 through March 2010 time periods. This extended period was selected in order to provide a better basis for discerning seasonal differences from year-to-year.<sup>60</sup>

<sup>60</sup> Each TDSP provided data for most of this period, but not necessarily the entire period. The data provided was sufficient to capture seasonal variations and perform the required analyses for each TDSP.



The request for historical electric usage information focused on information for each customer premise (ESI ID), rather than specific customers.<sup>61</sup> While people may move from one place to another, electric meters typically stay in place. The electric usage information produced by the TDSPs provided historical data for each meter ESI ID (i.e., specified meter location) whether there was an electromechanical meter in place or an advanced meter. As such, electric usage data was provided for each ESI ID both before and after advanced meter installation. Customer changes during the relevant period were noted in the information provided so that our analysis could take that into consideration.

### 3. Selection of Random Sample (Advanced Meters)

Navigant Consulting analyzed historical electric consumption of the relevant population of residential customers with advanced meters (i.e., total advanced meters approved for use), as well as a random sample of advanced meters. Analysis of the total relevant population of advanced meters provided a broader perspective, as well as potentially eliminated statistical error associated with the selection of the sample.

From the identified relevant population of advanced meters, a random sample of 1,154 advanced meters was selected for CenterPoint and 1,214 was selected for Oncor. The samples were selected for purposes of evaluating both the accuracy of the advanced meters (see Bench Testing results discussed in *Section V. Accuracy Testing of Advanced Meters*) and the historical electric usage analysis discussed in this section of the Report.<sup>62</sup> Random sample selection (i.e., where each advanced meter in the total population had an equal likelihood of being selected for the sample) was employed with regard to the advanced meters to minimize bias and to ensure representativeness of the total population of advanced meters.

### 4. Selection of 'Matched' Control Group (Electromechanical Meters)

A 'matched' control group of electromechanical meters was selected in order to create an appropriate basis of comparison for the consumption patterns of the sample of advanced meters. Given that advanced meter deployment has occurred primarily by geographic area, a random sample of customers with electromechanical meters would entail sampling from different, albeit contiguous, geographic areas that may have introduced some differences in a random sample of electromechanical meters versus a random sample of advanced meters.<sup>63</sup> As an alternative, Navigant Consulting used a controlled matching process to identify a sample of electromechanical meters to avoid potential inconsistencies due to where advanced meters were installed.

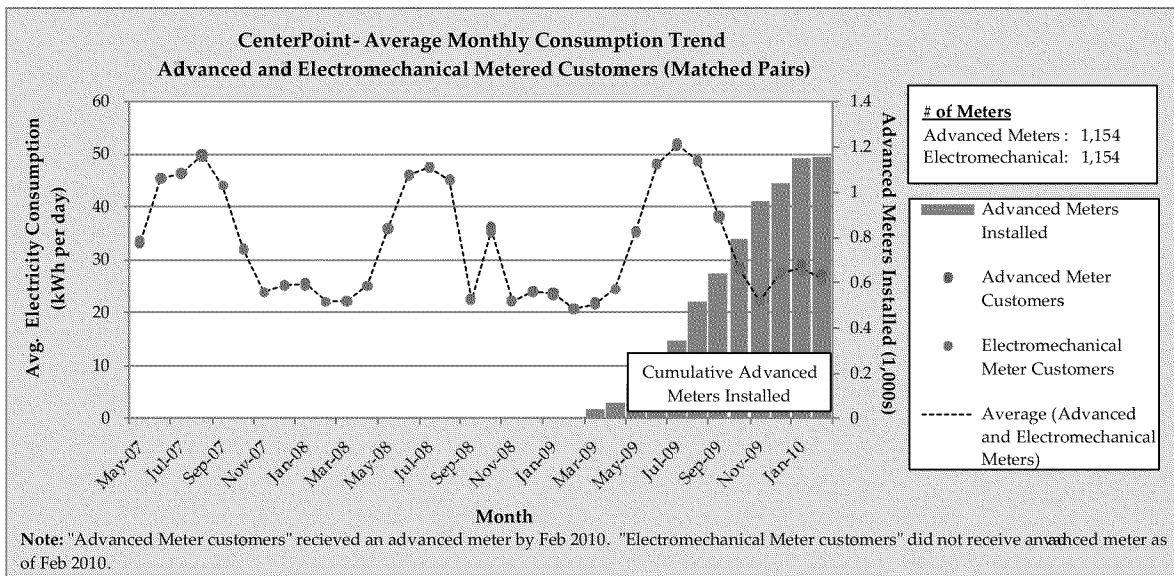
<sup>61</sup> An ESI ID (Electric Service Identifier) is a unique premise identifier, which is associated with service accounts for electricity delivery points.

<sup>62</sup> Only 2,117 advanced meters were removed from service and tested for accuracy. Certain meters were either inaccessible, inactive or otherwise could not be changed out prior to our testing process.

<sup>63</sup> Demographical differences in home size, usage patterns, proportion of gas to electric heat, etc. could have an impact on observed electric consumption for households receiving advanced meters early in deployment versus those receiving advanced meters later in deployment.

The matched control group of electromechanical meters was selected by comparing the electric usage history of customers with electromechanical meters to customers who currently have advanced meters (but before their advanced meter was installed) and matching customers with similar consumption patterns over time. Conceptually, the analysis provides the best basis of comparison of electric usage history by customers with and without advanced meters as we know that both groups had similar (or , matched ') consumption patterns before the customers currently with advanced meters received their advanced meters.

Figure 43 illustrates the results of the matching process for the CenterPoint sample of advanced meters. The average electricity consumed by the sample of households with advanced meters is shown as blue dots, while the average consumption by the matched households with electromechanical meters is shown as red dots. As expected, the average consumption for the matched groups is similar for each month in the observation period.



### 5. Data Standardization (e.g., Accounting for Variable Billing Periods)

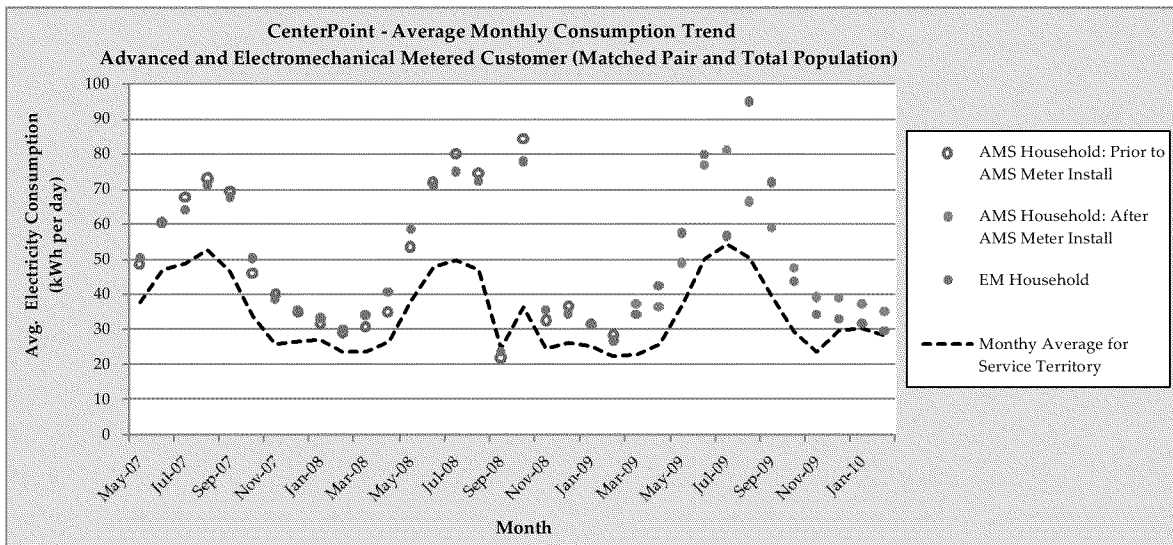
Once the sample of advanced meters and the controlled match sample of electromechanical meters were identified, the historical electric usage data was standardized to provide a meaningful basis of comparison. As usage information is provided in monthly increments (corresponding with a customer's monthly bill), some customers are billed on different billing cycles and dates than others (e.g., some customers may be billed on the 1<sup>st</sup> of each month, whereas others may be billed on the 15<sup>th</sup>). As a result, some limited amount of standardization is required to put customers on the same basis for comparison. The standardization process used allows the consumption patterns of individual meters to be compared over time and also makes them useable in statistical analysis.

### 6. Structure of Electric Usage / Consumption Analysis Results

The results of the controlled matching process of advanced and electromechanical meter households are called , matched pairs '. Examining the results of matched pair households can help

isolate the potential impact, if any, that the installation of advanced meters may have had on observed electric usage. Since historical electric consumption in these households had been similar prior to installation of an advanced meter, any identified differences in consumption between the matched pairs after installation of an advanced meter would need to be evaluated further.

Examination of the matching process and the consumption patterns for a matched pair of meters, after the data has undergone standardization, provides an overview of the more detailed statistical analysis performed. *Figure 44* shows the consumption patterns of a single pair of households, one advanced meter household and one electromechanical meter household, against the average household consumption for the CenterPoint service territory.



The horizontal axis is the period by month. The vertical axis represents the *average amount of electricity consumed per day* during each month in kilowatt hours (kWh). The dashed line displays the average daily household consumption across the relevant population. The red dots indicate the electromechanical meter household. The blue dots indicate a household that received an advanced meter in early 2009. Prior to the advanced meter being installed, the blue dot is left open (i.e., ○) indicating that the premise still had an electromechanical meter at that time.

Note that there is significant variation in the average consumption, as well as the daily average per-household consumption, over time – in some months the advanced meter household consumes more, while in others the electromechanical meter household consumes more. This illustrates the challenge in evaluating the potential impact, if any, of advanced meters on observed electric usage, and the need for rigorous statistical methods to examine these differences across a representative sample or population of households.

### 7. Statistical Methods Used

Statistical analysis is often used to evaluate the relationship among variables – in this case whether the deployment of advanced meters, in place of electromechanical meters, had an impact on the

recorded amount of electricity used by customers with advanced meters. Regression analysis is the statistical tool used most often to assess whether a statistically significant relationship between two or more variables exists.

Navigant Consulting performed various types of statistical analyses including one-way and two-way fixed effects regressions models, ordinary least squares regression models, and analysis of population deciles (or percentiles) and residuals in comparing the electric use history of Oncor and CenterPoint households with advanced meters to households with electromechanical meters. The common objective of the analyses was to examine whether advanced meters had caused a general distributional shift (i.e., changes in mean or average, variance or distributional shape) in the amount of electricity consumed by customers with advanced meters relative to those without.

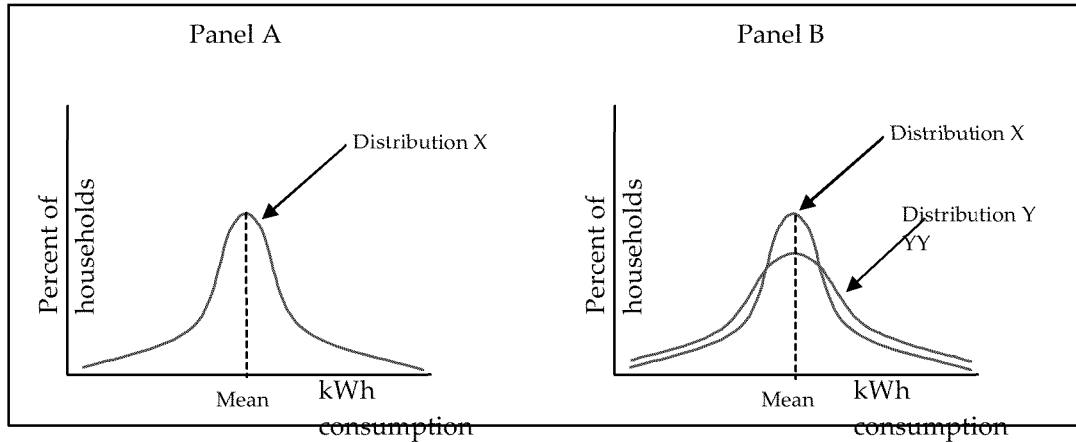
The impacts of hot and cold weather were evaluated in the statistical analyses by incorporating heating degree days (HDD) and cooling degree days (CDD) as explicit regression variables. The resulting models demonstrated that HDD and CDD are significant predictors of overall average energy use. However, there are other factors involved as well. As such, differences in consumption that may be related to the installation of advanced meters must be isolated from other potential causal effects, as well as weather.

In essence, the analytical techniques employed were utilized to evaluate observed differences between the average amount of electricity consumed by a household with an electromechanical meter and the average amount consumed by a household with an advanced meter. If the two relevant populations of advanced and electromechanical meters were homogenous (i.e., relatively the same) one would expect that random samples from those two populations would display the same amount of average energy consumption over time (i.e., all else being equal). However, differences can occur for various reasons that are unrelated to whether an advanced or electromechanical meter is installed.

Where differences were identified, we proceeded to analyze these differences through additional regression analyses to evaluate whether the differences could be attributed to certain other effects such as differences due to the number of heating or cooling degree days (or climate zone), differences due to heating source (i.e., gas or electric), differences due to when the advanced meters were installed, or differences due to the type of residential structure (i.e., apartment or single-family home).

We also analyzed whether observed differences were more pronounced at different levels of consumption within the population (e.g., households that have relatively high kilowatt hour consumption on average versus households that use relatively low amounts of kilowatt hours each month). By employing population decile regression analysis, we were able to examine differences in average electricity consumption between advanced and electromechanical meter households at various population consumption percentiles (e.g., 10<sup>th</sup> percentile, 20<sup>th</sup> percentile, etc.). As an example, if the average electricity consumption at the 10<sup>th</sup> percentile for a given month is 34.6 kWh per day, that indicates that for that month 10% of the population consumed less than 34.6 kWh per day and 90% of the population consumed more.

Figure 45 illustrates several distribution curves of average electricity consumption. Panel A presents a roughly normal distribution (bell curve) of consumption within the population (i.e., where some customers consume less than the average and others consume more). A population decile regression analysis seeks to address whether the installation of advanced meters is affecting this distribution.



The emphasis on the distribution of consumption across households, rather than simply the average consumption, serves to uncover any evidence of a change in the shape of the consumption distribution over time that may not be revealed by examination of only the average consumption. Panel B illustrates how such a situation might exist: Distributions X and Y have the same average or mean consumption, but distribution Y has more 'spread'. The objective of such an analysis is to determine whether the installation of advanced meters has any impact on the *distribution* of average electricity consumed by customers with advanced meters as compared to those without.

#### E. Observations and Findings – CenterPoint

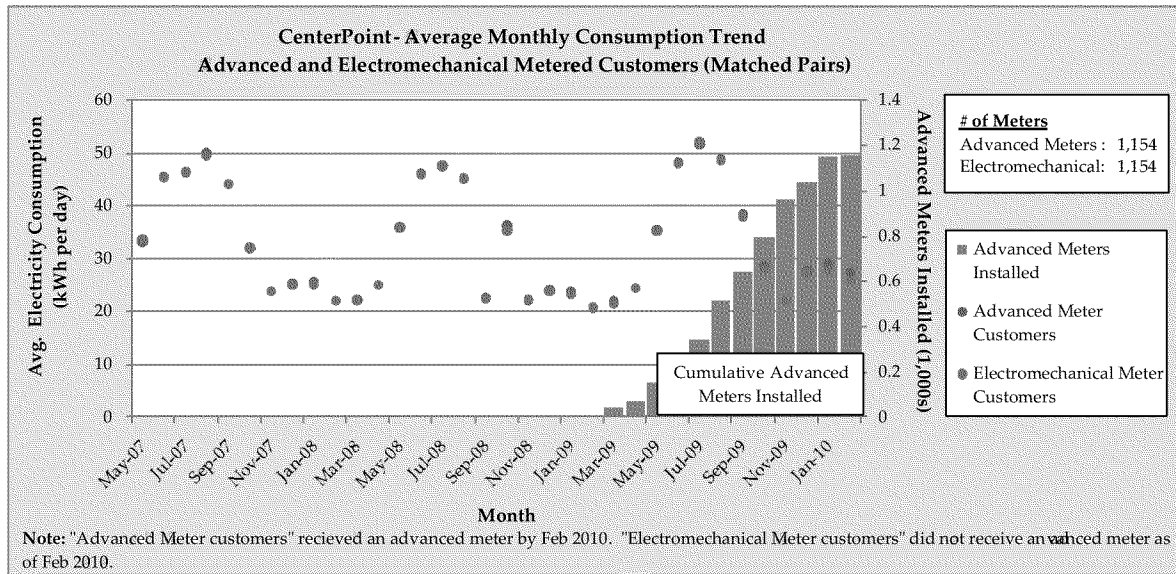
The statistical analysis based on the historical consumption data provided by CenterPoint *indicates no evidence that advanced meters have had a systematic, causal effect on individual household consumption*. In other words, there is no statistically significant evidence that the installation of advanced meters by CenterPoint has had an impact on the average electric usage by electric customers in its service territory.

While the results of our analysis indicated that advanced meter households appear to consume slightly less electricity, especially in summer, than households with electromechanical meters, this result is not related to the installation of advanced meters. The analysis suggests that households receiving advanced meters initially were low-energy users compared to those receiving them later.

##### 1. Analysis of a Random Sample of Advanced Meters

As described, we compared the average amount of electricity consumed by each household in our random sample of advanced meters to the average amount of electricity consumed by a matched electromechanical meter household with a similar consumption history. Figure 46 below provides

a summary of the results of the analysis of the CenterPoint random sample of households with advanced meters and the matched sample of households with electromechanical meters.



The difference between average kilowatt hours (kWh) per month for the advanced meter households and their matched electromechanical households is relatively small for most months during the period of analysis, including the summer and fall of 2009 when advanced meters started being deployed in larger numbers. The resulting absence of observed differences in average consumption between advanced meter and electromechanical meter households would support, with high confidence, that advanced meters are not systematically affecting recorded electricity consumption. However, there is some separation in consumption noted between the advanced and electromechanical meters households in the winter of 2009 / 2010, which is further discussed below.

a) Regression Analysis: One-way Fixed Effects Model

The controlled match of advanced meter and electromechanical meter households used in our sample serves to control for many unobservable effects that might otherwise bias the analysis, but it does not eliminate all possibilities. As such, one-way fixed effects regression analysis was utilized to evaluate whether the observed differences between the advanced meter households and the matched electromechanical meter households could be due to the installation of the advanced meters. The results of the one-way fixed effects regression analysis further support that, on average, *there is no statistically significant difference in consumption between advanced meter households and their matched electromechanical meter households.*

The slight disparity between advanced meters and their electromechanical meter matches in the winter of 2010, as observed in *Figure 46* appears to be due to the fact that on average households with advanced meters consumed slightly more kilowatt hours (kWh) than the households with electromechanical meter households in cold weather, with or without advanced meters, and the winter of 2010 was colder than usual.

b) Regression Analysis: Two-way Fixed Effects Model

Navigant Consulting also utilized a two-way fixed effects model to evaluate each cross-section (i.e., matched pair of households) during each time period to account for other differences that may have been unrelated to the installation of advanced meters. The results of the two-way fixed effects regression analysis also supported that, on average, *there is no statistically significant difference in consumption between advanced meter households and their matched electromechanical meter households.*

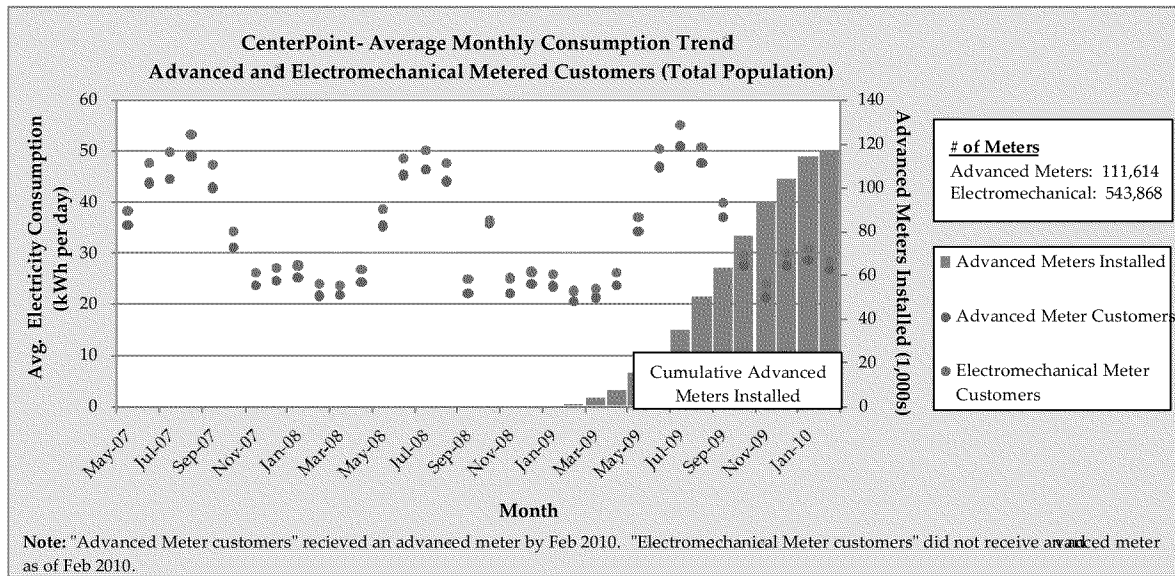
2. Analysis of the Population of Advanced Meters

a) Comparison of Average kWh Consumption – Least Squares Method

The statistical evidence from analysis of the matched pairs of advanced and electromechanical meters described above is that *advanced meters, on average, do not affect monthly electricity consumption.* However, Navigant Consulting sought to extend this analysis by calculating the average monthly difference in consumption of kilowatt hours (kWh) between advanced and electromechanical households for the relevant population of households in the CenterPoint service area, and then using regression analysis to see if average differences could be attributed to the relative frequency of advanced meters installed.

In comparing the average consumption of households with advanced meters to households with electromechanical meters in the relevant population we observe that there is a statistically significant baseline difference in the average daily kilowatt hour (kWh) consumption between the advanced and electromechanical meter households of approximately 1.64 kWh per day. However, the question is whether the observed difference is related to the installation of advanced meters, or some other effect.

*Figure 47* shows the average monthly kWh consumption of advanced and electromechanical meter households during the analysis period, as well as the number of advanced meters installed in the CenterPoint service area. The figure indicates a difference in average consumption between advanced and electromechanical meter households that gets larger during the summer months.



However, Navigant Consulting analyzed these differences relative to the number of advanced meters installed and determined that *the proportion of households with advanced meters appears to have no statistically significant effect on this difference*. In other words, the observed average monthly difference in kilowatt hour (kWh) consumption between advanced and electromechanical meter households is not a result of the installation of advanced meters or the percent of advanced meters installed. Without additional data it is not possible to firmly establish the reason for the difference in average kilowatt (kWh) consumption between the two household groups, but a reasonable hypothesis is that households receiving advanced meters earlier in CenterPoint's deployment were, on average, smaller and more urban, with a lower percentage of homes with central air conditioning.

b) Analysis of Consumption Percentiles – Population Decile Regression

Having established that the average or mean difference in average electricity consumption between advanced and electromechanical meter households is not due to the presence or absence of advanced meters, we also examined whether there was any change in some other aspect of the distribution of kilowatt hour (kWh) consumption among advanced meter households that was due to the installation of the advanced meters. In other words, we sought to address whether the presence of advanced meters resulted in one or both of the tails of the distribution of kilowatt hour (kWh) consumption among advanced households to change or shift relative to the distribution of kilowatt hour (kWh) consumption for electromechanical meter households.

As previously described, we examined the issue of changes in the distribution by applying the regression analysis to monthly differences between advanced and electromechanical meter households at various percentiles of consumption. For instance, comparing the 10th percentile for advanced meter households and electromechanical meter households across months in a regression analysis allows a test of whether the installation of advanced meters affected the 10th percentile of the average consumption distribution.



The results of the population regression decile analysis were not inconsistent with the previous comparison of the average or mean consumption by advanced and electromechanical meter households. More specifically,

- Across the percentiles, electromechanical households consume more electricity than advanced meter households;
- This difference in consumption is greater in the summer, as indicated by the statistical significance of cooling degree days; and
- The percentage of households with advanced meters installed has no statistically significant effect on the observed differences between the advanced and electromechanical meter households.

*This last point deserves emphasis: Not only does the installation of advanced meters appear to have no systematic effect on the mean kilowatt hour (kWh) consumption within the population, but it appears to have no effect on any aspect of the distribution of consumption in CenterPoint's service area.*

#### F. Observations and Findings – Oncor

The statistical analysis based on the historical consumption data provided by Oncor indicates that households with advanced meters appear to consume slightly more electricity on average than households with electromechanical meters (i.e., approximately 1 kWh or 2.5% more per day). However, while the possibility exists that the deployment of advanced meters has had an impact on the average metered electricity consumed by the average household with an advanced meter, *we do not believe that advanced meters have had a systematic, causal effect on individual household consumption.*

While the results of our analysis indicate that advanced meter households on average appear to consume slightly more electricity than households with electromechanical meters (approximately 1 kWh per day), and that the observed effect was consistent across both the random and controlled match sample of advanced and electromechanical meter households, as well as across the relevant populations, the observed differences decrease and become statistically insignificant over time (i.e., the longer a household has had an advanced meter).

This observation raises questions both as to the sufficiency and reliability of the data when the length of period available for comparison between advanced and electromechanical meter households is not longer than 12 months (i.e., a significant number of advanced meters were deployed in mid-to-late 2009) and whether we have sufficient periods of comparison to properly evaluate the effect of other explanatory variables (e.g., heating degree days) on the observed differences in average consumption. However, it also raises the possibility of a more recent occurrence that is influencing the observed average 1 kilowatt hour (kWh) per day difference.

In addition, while we were able to evaluate the relationship between many variables affecting electric consumption, we did not evaluate the potential impact of the accuracy of electromechanical

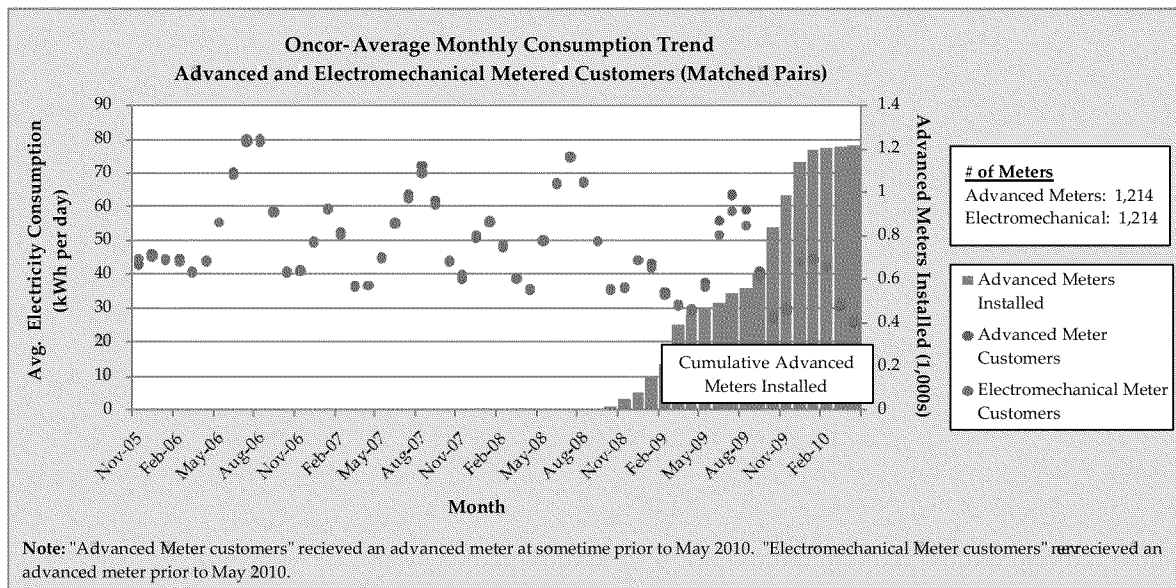
meters in the statistical analysis. It is important to point out that it is reasonable to expect that advanced meter households would, on average, result in higher metered electricity usage than electromechanical meter households given the relative age and perceived inaccuracy of older electromechanical meters. It is widely understood that electromechanical meters, while having the capability to remain accurate, will generally slow down over time (i.e., record less electricity usage than actually used by the household). While this observation is dependent on many factors, a 1 – 2% difference, or perhaps greater, is not uncommon for meters that exceed 20 years in age. The average age of electromechanical meters in use by Oncor is over 25 years.

Further, the possibility exists that our statistical models were unable to adequately address certain variables resulting from the non-random deployment and installation of advanced meters in Oncor’s service area.

Each of these factors prevents us from concluding that the observed difference of 1 kilowatt hour (kWh) per day in individual household consumption is the result of a systematic, causal effect of advanced meters.

1. Analysis of a Random Sample of Advanced Meters

As described, we compared the average amount of electricity consumed by each household in our random sample of advanced meters to the average amount of electricity consumed by a matched electromechanical meter household with a similar consumption history. *Figure 48* below provides a summary of the results of the analysis of the Oncor random sample of households with advanced meters and the matched sample of households with electromechanical meters.



The difference between average kilowatt hours (kWh) per month for the advanced meter households and their matched electromechanical meters households is relatively small for most months during the period of analysis. The resulting absence of any observed differences in average

consumption between advanced meter and electromechanical meter households would support, with high confidence, that advanced meters are not systematically affecting recorded electricity consumption. However, there is some separation in average consumption noted between the advanced and electromechanical meters households during the summer of 2009.

a) Regression Analysis: One-way and Two-way Fixed Effects Models

Both one-way and two-way fixed effects regression analyses were utilized to evaluate whether the observed differences between the advanced meter households and the matched electromechanical meter households could be due to the installation of the advanced meters. The results of both the one-way and two-way fixed effects regression models supported that, on average, *there was a small difference of approximately 1 kilowatt hour (kWh) per day on average in consumption between advanced meter households and their matched electromechanical meter households that required additional analysis.*

Additional, and more complex, regression analyses were performed to further analyze and potentially isolate the causal effect that could be attributed to the observed difference in average kilowatt hour (kWh) consumption between the advanced and electromechanical meter households. More specifically, we included other variables in our regression analyses to evaluate the potential effect of the following:

- Meter type / version (i.e., Oncor has three meter types in service)
- Heating source type (i.e., electric versus other)
- Residence type (i.e., single family home versus apartment)
- Estimated bills
- Month of conversion to automated meter reading

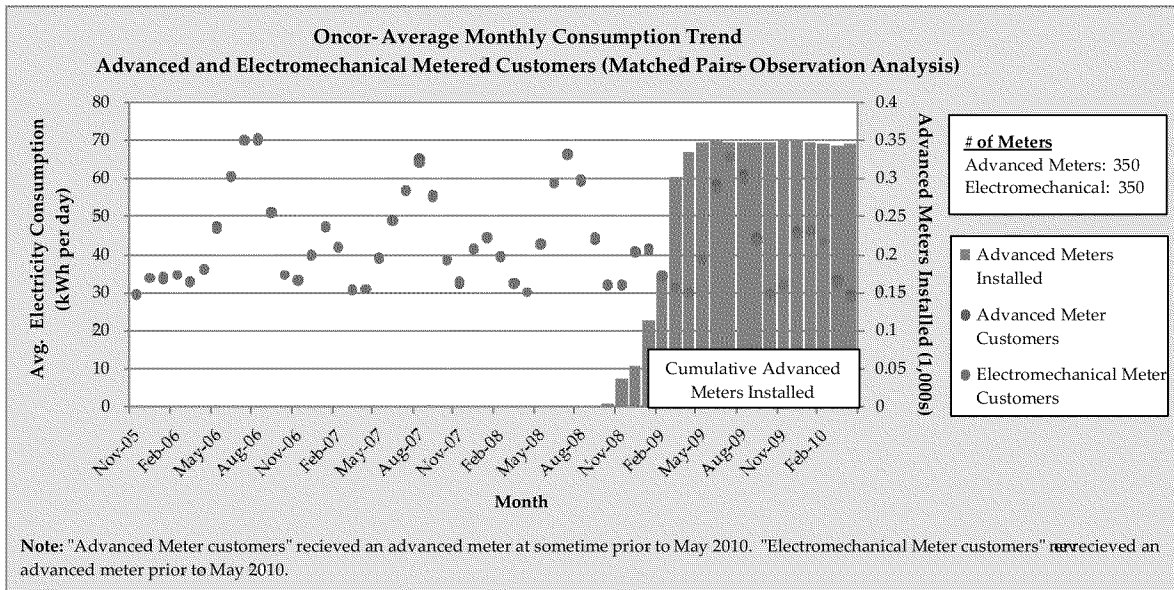
The results of these regression analyses were generally consistent with our initial observations and did not provide any further explanation of the observed 1 kilowatt hour (kWh) per day difference in consumption between advanced meter households and their matched electromechanical meter households.

b) Analysis of Subsets of Matched Pairs

Navigant Consulting further examined the potential effect resulting from the number of observations we had in the matched pairs, as well as the relevant populations of advanced and electromechanical meters. Each of the matched pairs was identified by matching the historical electric consumption of current households with advanced meters to households with electromechanical meters. Some matched pair households had longer periods (i.e., months) where the individual household consumption was matched and some had shorter periods. Given the significant number of advanced meters that were deployed in mid-to-late 2009 and early 2010, we did not always have a significant number of months in which to match the individual households. In order to evaluate whether the number of matched periods (i.e., the sufficiency of the data) had an impact on the observed results, we ran several regression analyses in which the criteria for inclusion in the analysis were 1) a minimum number of months of data for the matched pair, and 2) a minimum number of months of data in which the advanced meter was installed in the household

with the advanced meter. One of which, the criteria for inclusion was that the matched pair have at least 48 months of consumption data and at least 12 months of consumption data in which the advanced meter was installed.

In doing so, we observed that the average difference in consumption per month between advanced and electromechanical meter households diminishes and becomes statistically insignificant the larger the number of monthly observations. *Figure 49* below provides a summary of the results where the matched pair had at least 48 months of consumption data and the advanced meter had been installed for at least 12 months. The results indicate that there is no longer evidence of divergence in consumption between households with advanced meters and their matches after the installation of the advanced meter.



While this does not answer all questions regarding whether there is a difference between the average energy consumed by a household with an advanced meter and a household with an electromechanical meter, or whether it could be attributed to the installation of advanced meters, it does support that *over time there appears to be no statistically significant difference between households with advanced meters and those with electromechanical meters.*

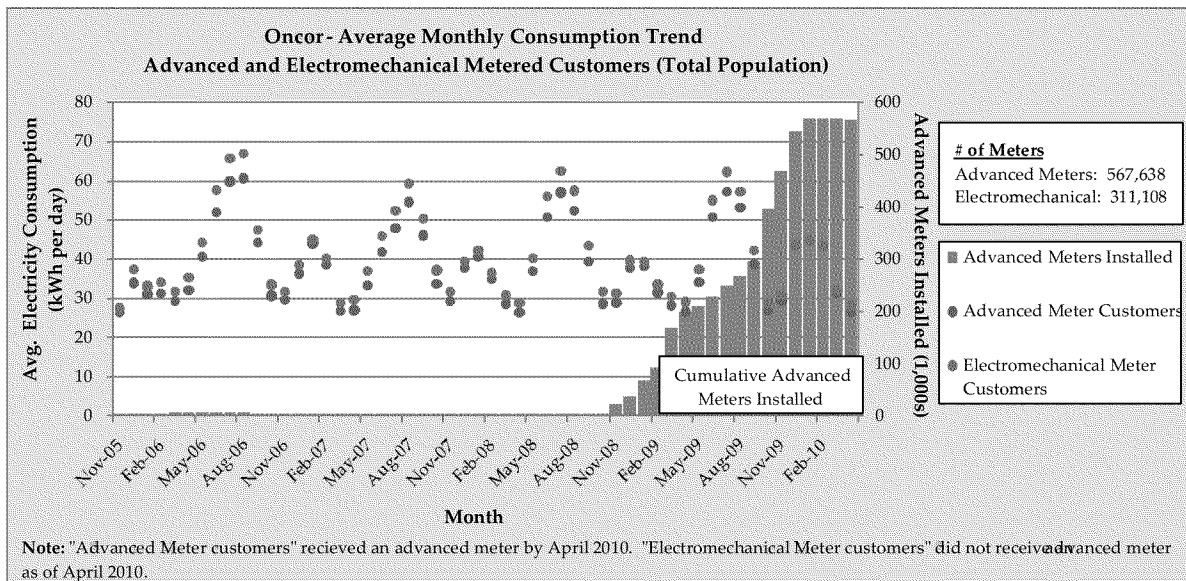
2. Analysis of the Population of Advanced Meters

a) Comparison of Average kWh Consumption – Least Squares Method

Navigant Consulting also analyzed the average difference in consumption of kilowatt hours (kWh) for advanced and electromechanical households for the relevant population of households in the Oncor service area. In comparing the average consumption of households with advanced meters to households with electromechanical meters in the relevant population we observed that there is a statistically significant baseline difference in the average daily kilowatt hour (kWh) consumption between the advanced and electromechanical meter households of approximately 1 kilowatt hour

kWh per day. However, as with the matched pair analysis described above, the question is whether the observed difference is related to the installation of advanced meters, or some other effect.

Figure 50 shows the average monthly kilowatt hour (kWh) consumption of advanced and electromechanical meter households during the analysis period, as well as the number of advanced meters installed in the Oncor service area. The figure indicates that the installation of an advanced meter is not correlated with an increase in consumption for households with an advanced meter installed early in the deployment period. However, for households with an advanced meter installed later in the deployment period, the analysis indicates that there is a small difference in the average kilowatt hours (kWh) consumption. As with the analysis of the matched pairs, we observed that this difference in average consumption is likely due to the lack of data (i.e., observations) in which to reliably compare advanced and electromechanical meter households for households that received an advanced meter later in the deployment period.



b) Analysis of Consumption Percentiles – Matched Pair Decile Regression

Navigant Consulting also examined whether there was any difference in the observed approximate 1 kilowatt hour (kWh) per day difference between advanced and electromechanical meter households in our matched pairs at different levels of consumption (i.e., at different percentiles in the population). As previously described, we examined the issue of changes in the distribution by applying the regression analysis to monthly differences between advanced and electromechanical meter households at various percentiles of consumption. The results of the population regression decile analysis were not inconsistent with the previous observations and provided additional insight into the potential causal effect of the observed difference, but produced no conclusive results. In summary, there appeared to be a larger difference in the average energy consumed between households with advanced meters and electromechanical meters the lower the average energy consumption per month.

**VIII. Analysis of Customer Complaints**

**A. Background**

In early 2010, an increase in customer complaints concerning higher electric bills was noted by the Commission, among others. A number of the complaints also questioned a possible connection between the higher electric bills and the recent installation of advanced meters. As part of Navigant Consulting’s scope of work, we were asked to analyze the increased incidence of customer complaints, especially in relation to concerns about higher electric bills, and evaluate whether there was, or is, any relationship between the complaints and the deployment of advanced meters, the accuracy of the meters, or the accuracy of the associated billing process.

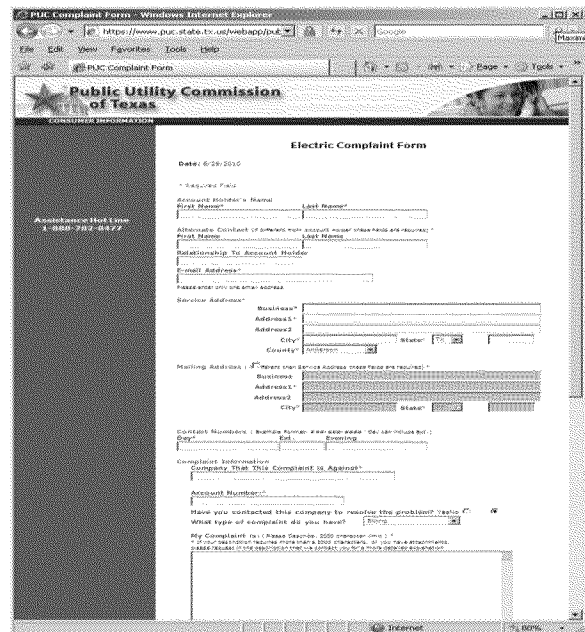
**1. Complaints Filed with the Commission**

It is not uncommon for electric customers to file complaints with the Commission for a variety of reasons. Customer complaints are addressed by the Commission through an established process that involves both the customer and the appropriate TDSP and/or REP. Customers also may make inquiries and complaints directly to TDSPs and REPs. As previously described, TDSPs are responsible for the transmission and distribution of electricity, while REPs are responsible for the actual billing of customers. As a result, certain types of complaints may be directed to the TDSPs while others to REPs, and in some cases both.

The Commission Procedural Rules, which govern the complaint process, state:<sup>64</sup>

*“...Any affected person may complain to the commission, either in writing or by telephone, setting forth any act or thing done or omitted to be done by any electric utility...which the commission has jurisdiction to administer...”*

The Commission provides multiple avenues to file an informal complaint. *Figure 51* is a copy of the Commission’s online complaint form. Informal complaints may be submitted via mail, telephone, facsimile, or online form and typically request general information about the customer, as well as a description of the facts and circumstances surrounding the complaint.<sup>65</sup>



<sup>64</sup> Commission Procedural Rules Subchapter M, ,Procedures and Filing Requirements in Particular Commission Proceedings' Section 22.242 ,Complaints' (,Commission Procedural Rules' ).

<sup>65</sup> The Commission advises customers to file an inquiry or complaint with the electric company prior to submitting an informal complaint to the Commission. The Commission also advises that the company should investigate the concern and communicate to the customer what action it plans to implement.

The Commission receives complaints in relation to various aspects of electric utility operations, not just in relation to customer billing concerns, including complaints related to the provision and quality of service, as well as discontinuance of service, among various others.

The Commission Procedural Rules require the Commission to attempt to resolve informal complaints in a short time period and assigns each inquiry and complaint it receives to an investigator for evaluation.<sup>66</sup> The investigator contacts the applicable electric company (i.e., REP, TDSP, etc.) and requires the company to investigate and respond to the Commission within 21 days. The Commission then provides both the customer and the electric company a letter with the investigator's conclusions.

## 2. Inquiries / Complaints Filed with the TDSPs and REPs

TDSPs and REPs also have inquiry and complaint resolution programs within their respective customer service departments. These processes are firmly established and address a variety of questions ranging from tree trimming concerns to electric service outages, as well as billing and meter related inquiries.

### **B. Scope of Work**

Navigant Consulting's scope of work was designed to evaluate whether the increased incidence of customer complaints, especially in relation to concerns about higher electric bills, had any relation to the deployment of advanced meters or the accuracy of those meters. Our investigation focused primarily on evaluating complaints submitted to the Commission from residential customers in the applicable TDSP service territories. Navigant Consulting reviewed the complaints for identifiable trends, patterns and/or inconsistencies and analyzed the incidence of complaints from customers with advanced meters in comparison to customers with electromechanical meters. Navigant Consulting also conducted a detailed review of customer electric usage related to the complaints in comparison to known weather trends, as well as in relation to other customers with advanced or electromechanical meters. In addition, our effort included a detailed analysis of certain higher electric bills complaints from residential customers in Oncor's service territory that were identified during the Field Testing phase of our work.

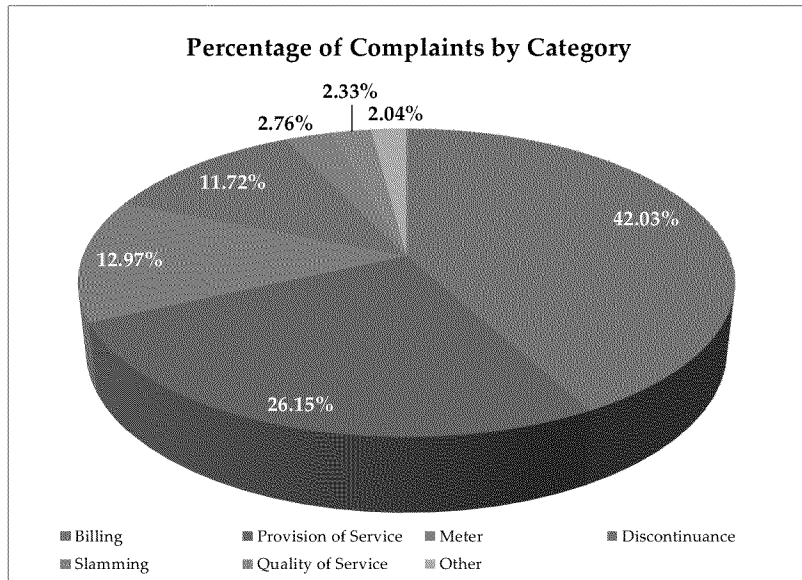
### **C. Work Performed**

#### 1. Identification of Applicable Complaints

The Commission provided Navigant Consulting access to its database of complaint records from residential electric customers that were filed between January 2007 and May 2010 ('Commission Database'). The Commission Database consists of customer complaints from across the state covering multiple TDSPs, REPs, Cooperatives, Municipalities and over 9.5 million households.

<sup>66</sup> The Commission Procedural Rules state, 'The commission staff shall attempt to informally resolve all complaints within 35 days of the date of receipt of the complaint < notify, in writing, the complainant and < whom the complainant is seeking relief of the status of the dispute at the end of the 35-day period.'

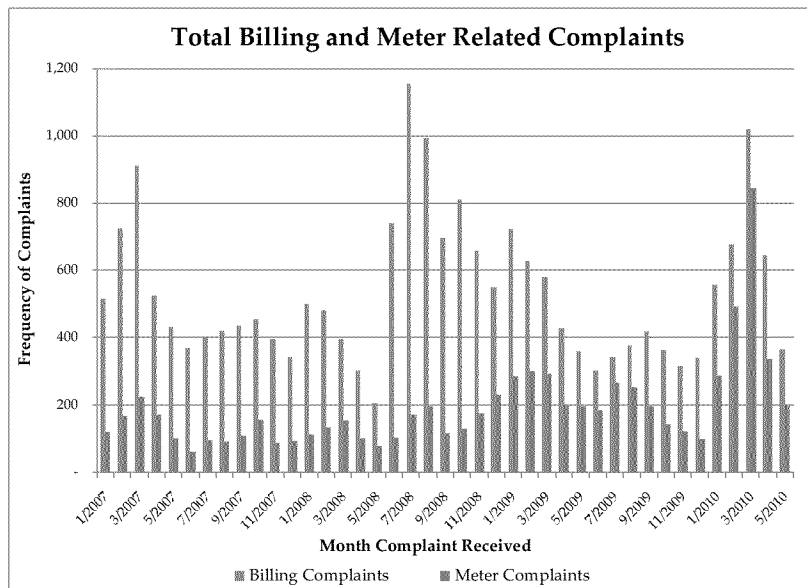
Figure 52 includes a pie chart that summarizes the complaint records in the Commission Database. The complaints are divided into categories and subcategories and contain information including the name and type of company (e.g., REP, TDSP, etc.), the subject of the complaint (e.g., customer service), and the date the complaint was filed (among other information), as well as certain information about the customer (e.g., name, address, etc.).



*55% of the complaints made between 2007 and 2010 were in relation to customer billing or meter related concerns or questions.*

Our efforts focused on evaluating complaints filed with the Commission that potentially related to customer billing and meter concerns.

Figure 53 includes a bar chart displaying the number of ,billing' and ,meter' related complaints submitted to the Commission between January 2007 and May 2010. The bars represent the number of billing and meter related complaints received by the Commission each month. Billing related complaints exceeded the number of meter related complaints each month.



*The frequency of customer billing and meter complaints has varied over time but generally tend to increase following summer and winter months when electricity use can be at its greatest. In early 2010, the number of meter complaints increased significantly, then subsequently declined by May.*



2. Correlation of Commission Complaints to TDSP Customers

An initial step in Navigant Consulting’s analysis involved matching either billing or meter related complaints in the Commission Database to actual customers in Oncor and CenterPoint service territories. AEP Texas was not included in our analysis given their limited deployment of advanced meters at the start of our investigation and few reported complaints at that time.

We utilized an approximate string matching process to compare name and address information from the Commission Database to information received from Oncor and CenterPoint.<sup>67</sup> The string matching process matched 3,018 complaints to a customer in Oncor’s service territory and 1,507 complaints to a customer in CenterPoint’s service territory (, matched complaints’) between January 2007 and March 2010.

The identified matched complaints include complaints from customers with electromechanical meters, as well as complaints before the start of deployment of advanced meters, to provide a basis of comparison and historical perspective from which to evaluate more recent complaints from customers with advanced meters. In addition, the matched complaints from customers with electromechanical meters represent complaints from less than a third of the total customers in the Oncor and CenterPoint service territories as we limited our evaluation of complaints to complaints from the same or contiguous areas (defined by zip code) as customers with advanced meters.

3. Correlation of Matched Complaints to Advanced v. Electromechanical Meters

We segregated the matched complaints into complaints from customers with either advanced or electromechanical meters based on meter install date. Of the 3,018 complaints matched to a customer in Oncor’s service area, 951 complaints were from customers with an advanced meter and 2,067 were from customers with electromechanical meters. Of the 1,507 complaints matched to customers in CenterPoint’s service area, 87 complaints were from customers with advanced meters and 1,420 were from customers with electromechanical meters. A summary of the matched complaints by meter type is summarized in *Table 15* below:

	Advanced Meter Complaints			Electromechanical Meter Complaints			Total Matched Complaints
	(,Billing')	(,Meter')	(Total)	(,Billing')	(,Meter')	(Total)	
Oncor	455	496	951	1,456	611	2,067	3,018
CenterPoint	42	45	87	1,006	414	1,420	1,507
<b>Total</b>	<b>497</b>	<b>541</b>	<b>1,038</b>	<b>2,462</b>	<b>1,025</b>	<b>3,487</b>	<b>4,525</b>

A total of 1,038 matched complaints were attributed to customers with advanced meters, with over 90% of those matched to customers in Oncor’s service territory. The vast majority of complaints

<sup>67</sup> The string matching process measures the number of operations necessary to transform a data element in one data set into a match in another. This process is often used when comparing or matching data sets that lack exact matches. We identified an appropriate similarity threshold and then manually reviewed all approximate matches that met or exceeded the threshold to determine if the matches were accurate.

from customers with advanced meters were also received in early 2010, as discussed in detail below.

4. Analysis of Complaints

a) Analysis of the Timing and Frequency of Total Complaints

Navigant Consulting analyzed the frequency and timing of total billing and meter related complaints filed with the Commission between January 2007 and May 2010 to identify any significant trends or patterns in the complaints relative to the deployment of advanced meters, as well as in comparison to average monthly temperatures and the number of heating and cooling degree days in each area. We also analyzed the timing and frequency of complaints relative to media coverage in areas regarding a potential link between advanced meters and billing concerns.

b) Analysis of Matched Complaints (Electromechanical v. Advanced Meters)

For each matched complaint, Navigant Consulting reviewed the relevant meter and customer account information and analyzed the general trends and patterns in electric usage for customers at each premise during the period between June 2006 and March 2010.<sup>68</sup> We compared the historical electric usage for customer premises (both customers with advanced and electromechanical meters) to each other and to a baseline of customer premises (with advanced or electromechanical meters) with no complaint. In addition, we evaluated the electric usage history of customer premises pre-installation and post-installation of an advanced meter.

c) Analysis of Specific Oncor Advanced Meter Customer Complaints

At the request of certain Oncor customers, Navigant Consulting also evaluated their specific concerns. Pursuant to the Field Testing of advanced meters in Oncor's service territory, Navigant Consulting was approached by various customers with concerns about their electric usage following installation of their advanced meter. Approximately 60 customers in Oncor's service area expressed an interest during our Field Testing of their meters to discuss their historical electric bills and related concerns. Navigant Consulting's analysis included discussions with these customers, a limited review of billing information provided, analysis of historical electric usage patterns and trends, and analysis of applicable interval and register read data as necessary.

<sup>68</sup> Monthly electric usage data was not readily available from CenterPoint's current data systems for periods prior to March 2007.

**D. Observations and Findings**

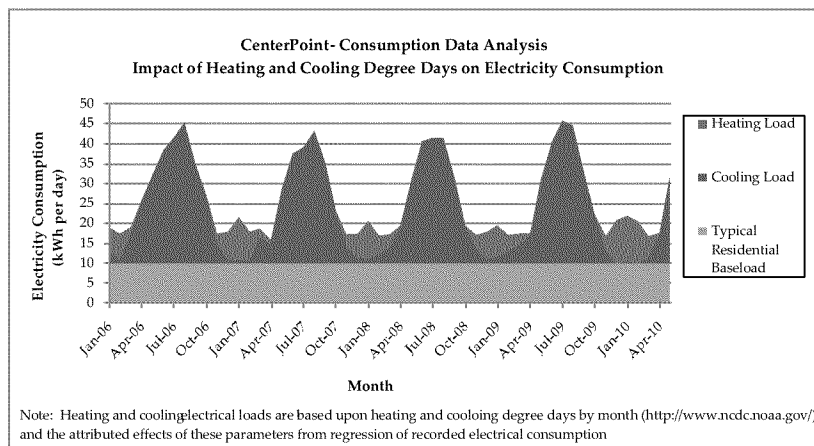
1. Frequency and Timing of Total Complaints

a) Correlation to Average Monthly Temperatures

Residential electric usage typically correlates directly to the increase and decrease in seasonal temperatures. Households typically have a base load of electric usage that represents the usage required to operate appliances, electronics and other items that are used on a daily basis regardless of the season. However, households typically experience significant increases and decreases in electric usage throughout the year due to the amount of energy required for heating and cooling.

Figure 54 displays a chart of the typical electric usage for a household including a typical customer base load, and heating and cooling load during the period January 2006 to April 2010.

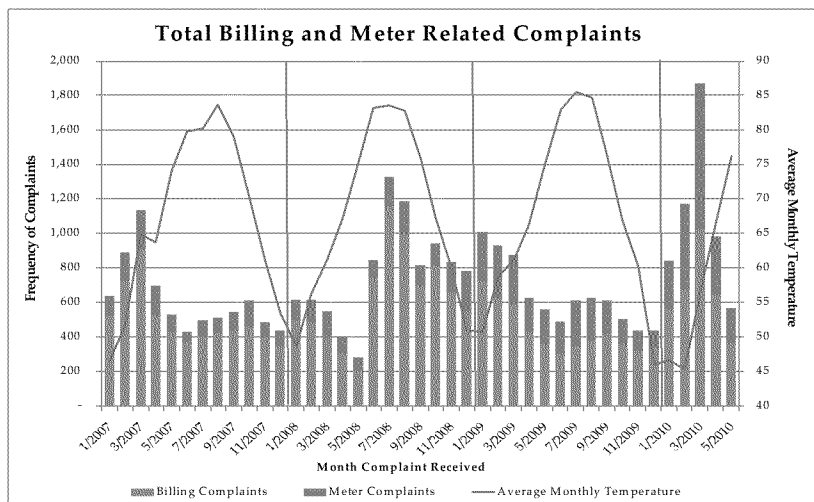
*The significant changes in electricity usage for a typical household relate to energy required for heating and cooling.*



There are peaks in electricity consumption during both the winter and summer months. The winter peak occurs due to the use of electric heat pumps and electric resistance heaters, while the summer peak is due to the use of air conditioners. The frequency of ,billing' and ,meter' related customer complaints to the Commission also has historically increased during the applicable billing periods following the summer and winter months in Texas.

Figure 55 displays a bar and line graph of ,meter' and ,billing' related complaints in comparison to monthly average temperature. The bars (left axis) represent the frequency of complaints. The line (right axis) represents the average monthly temperature.

*The timing and frequency of complaints generally follow changes in temperatures.*

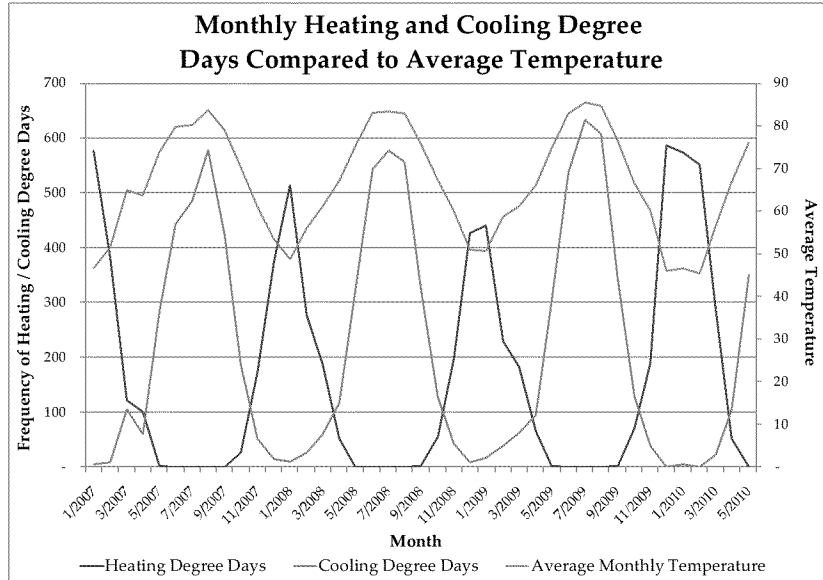


b) Correlation to Monthly Heating and Cooling Degree Days

Navigant Consulting also analyzed historical electric usage in comparison to monthly heating and cooling ,degree days' in each area. The number of heating and cooling degree days is determined by calculating the difference between the average daily temperature and 65 degrees (where the average is the average of the day's high and low temperatures). Average temperatures above 65 degrees result in cooling degree days and those below 65 degrees result in heating degree days.

Figure 56 displays the relationship between monthly temperature and monthly heating and cooling degree days. The red and blue lines represent the heating and cooling degree days per month, while the green line represents the average temperature each month.

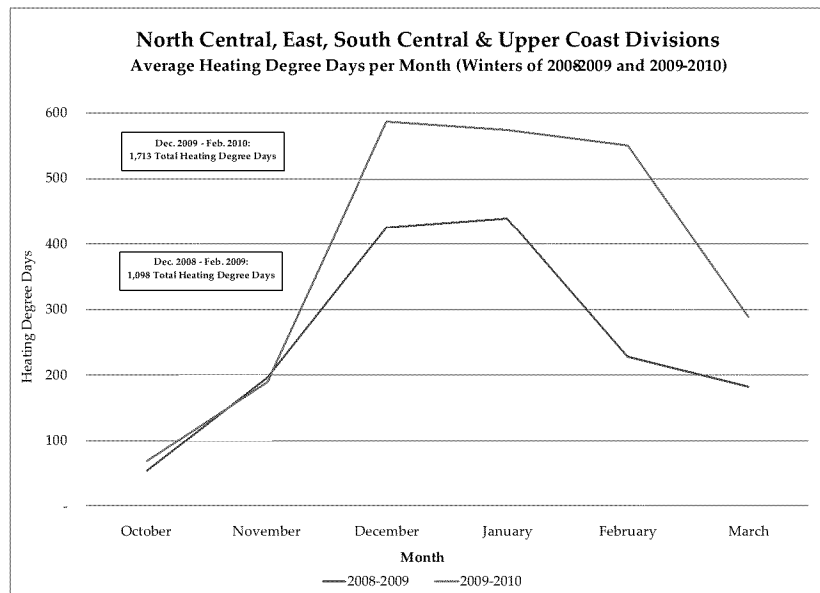
Heating and cooling degree days increase/decrease in relation to the rise and fall of temperatures.



Months with a greater number of heating and cooling degree days typically result in increased electric usage. However, the influence of degree days on an individual consumer can vary greatly depending on the type, age, and maintenance of a consumer's heating and air-conditioning system.

Figure 57 displays a graph with the average number of heating degree days in the Oncor and CenterPoint service areas during the past two (2) winters (i.e., 2008-2009 and 2009-2010).

The most recent winter in Texas from December 2009 through February 2010 had 615 more heating degree days (or 56% more) than the prior winter in late 2008 and early 2009.

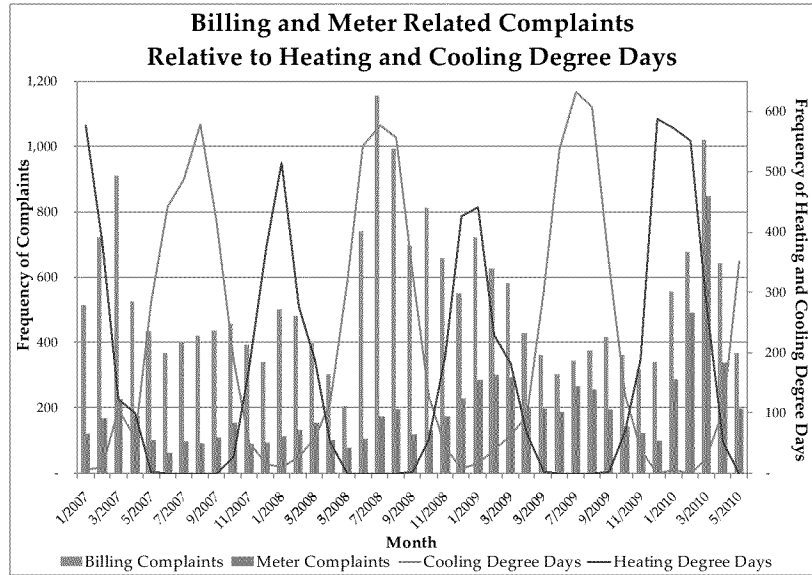


The timing and frequency of complaints also are generally consistent with increases and decreases in the number of heating and cooling degree days. The significant increase in the number of heating degree days during the 2009 / 2010 winter is also evident in comparison to prior years.

Figure 58 displays a bar and line graph of the frequency of ,billing' and ,meter' complaints in comparison to heating and cooling degree days.

The frequency and timing of complaints corresponds to changes in average heating and cooling degree days.

In early 2010 the number of "meter" related complaints increased significantly.

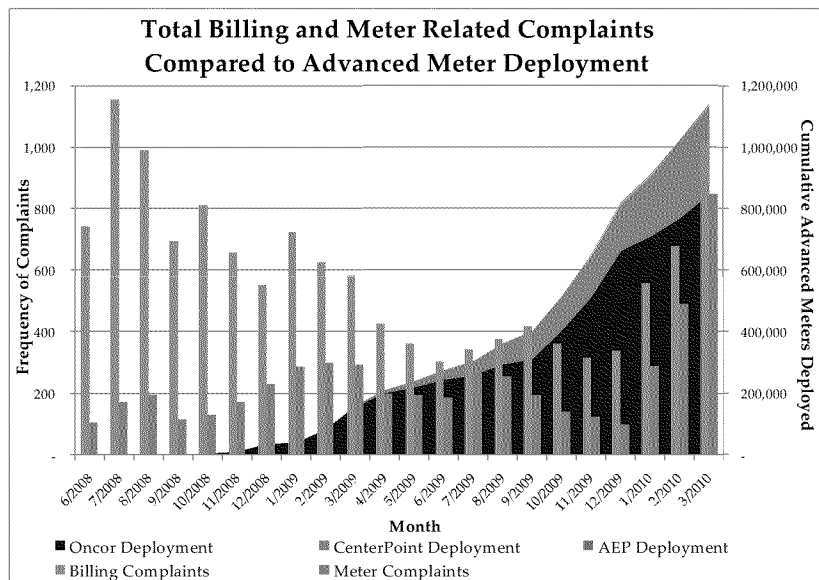


c) Correlation to Advanced Meter Deployment

We also evaluated the timing and frequency of total ,billing' and ,meter' related complaints to the Commission in relation to the start of the advanced meter deployment and the total number of advanced meters deployed. The deployment of advanced meters by Oncor and CenterPoint began in October 2008 and February 2009 respectively.

Figure 59 displays a bar and area graph comparing the frequency of ,billing' and ,meter' related complaints to the number of advanced meters deployed from June 2008 through May 2010.

The number of complaints in the first 12 months following advanced meter deployment was consistent with prior periods and trends until early 2010 and the increase in "meter" related complaints.

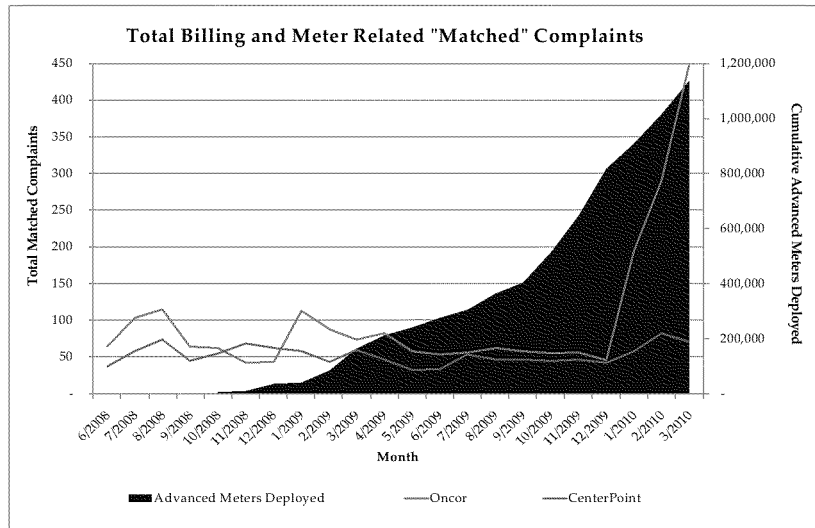


2. Analysis of Matched Complaints (Electromechanical v. Advanced Meters)

We identified 3,018 billing and meter related customer complaints to the Commission that matched to customer premises in Oncor’s service area, and 1,507 matched complaints in CenterPoint’s service area. The matched complaints covered a period from early 2007 through May 2010 to provide a meaningful period to evaluate longer-term trends and patterns in customer complaints.

Figure 60 displays a line and area graph comparing the frequency of matched complaints to advanced meter deployment.

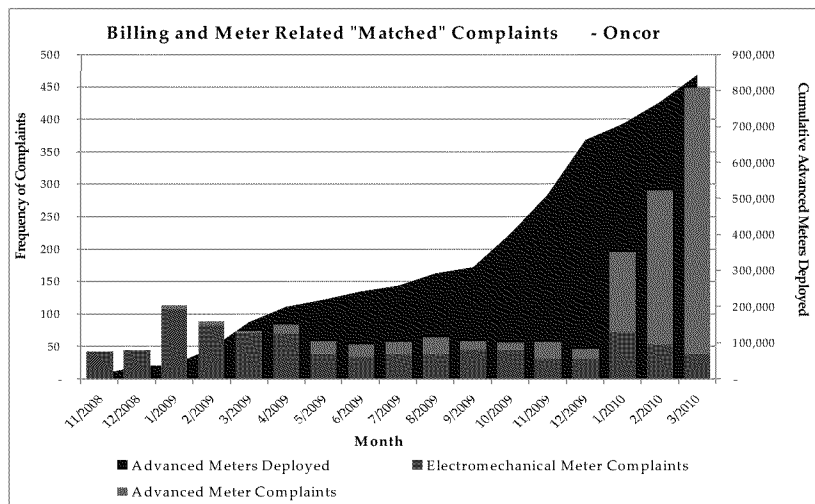
The frequency of matched complaints did not change significantly in the first 12 months of deployment for Oncor or CenterPoint. However, complaints from customers in Oncor’s service territory increased significantly in early 2010.



Oncor Matched Complaints

Of the 3,018 Oncor matched complaints, 1,820 were complaints made since the start of Oncor’s deployment of advanced meters in November 2008. 951 (or ~52%) of those complaints were complaints from customers with advanced meters, with the vast majority made in early 2010.

Figure 61 summarizes the timing and frequency of matched complaints from customers in Oncor’s service territory during the period of advanced meter deployment from November 2008 to March 2010. The left axis represents the number of matched complaints and the right axis is the total number of advanced meters deployed during the period.

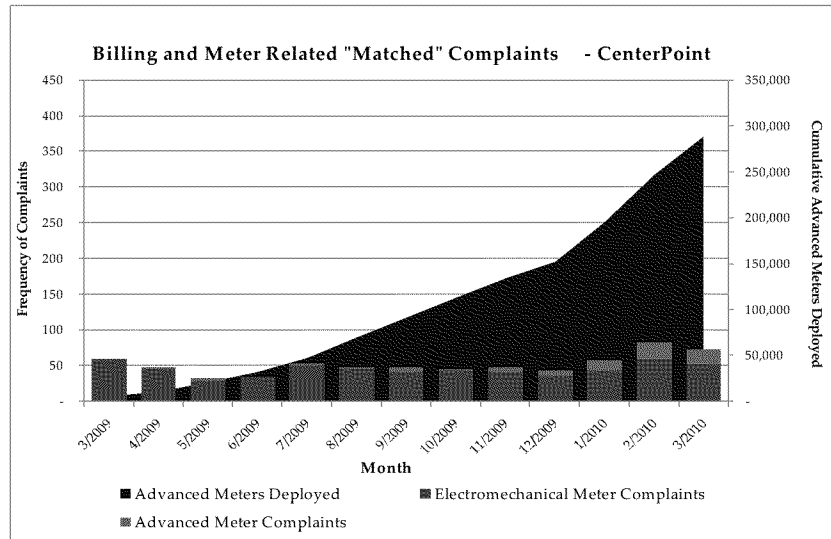


The frequency of customer complaints was relatively unchanged during the first 12 months of Oncor’s advanced meter deployment. However, beginning in 2010, complaints from customers with advanced meters increased significantly.

CenterPoint Matched Complaints

Of the 1,507 complaints matched to customers in CenterPoint’s service area, 665 were complaints made since the start of CenterPoint’s deployment of advanced meters in March 2009. A total of 87 (or ~13%) of those complaints were complaints from customers with advanced meters.

Figure 62 summarizes the timing and frequency of matched complaints from customers in CenterPoint’s service territory during the period of advanced meter deployment from March 2009 to March 2010. The left axis represents the number of matched complaints and the right axis is the total number of advanced meters deployed during the period.



*The frequency of matched complaints, as well as the proportion of complaints from customers with electromechanical versus advanced meters was relatively unchanged during the first 12 months of CenterPoint’s advanced meter deployment. While complaints from customers with advanced meters increased in early 2010, the increase generally was consistent with the seasonal nature of complaints from customers following the winter months.*

Based on our analysis of the identified matched complaints, there was not a significant or corresponding increase in complaints from customers with advanced meters in CenterPoint’s service territory similar to that observed for customers in Oncor’s service territory in the first few months of 2010. In addition, the number of complaints received from customers in CenterPoint’s service territory generally was consistent with historical complaints received by CenterPoint prior to their deployment of advanced meters, as well as in relation to the severity of the past winter in Texas. **As a result, the remaining analysis and discussion in this section of the Report is focused on the matched complaints from customers with advanced meters in the Oncor service area.**

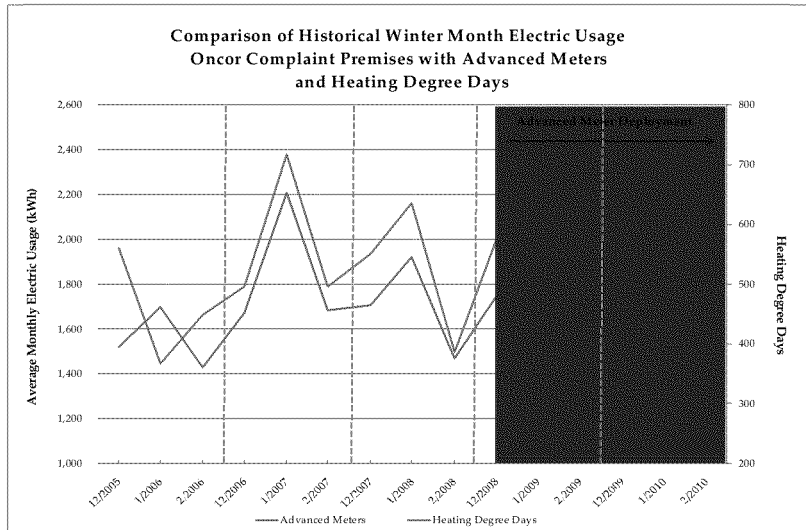
With regard to our continued evaluation of matched complaints from customers in Oncor’s service area, Navigant Consulting analyzed the historical electric usage of these customer premises relative to various factors including the number of heating degree days, the average electric usage of customers with complaints and electromechanical meters, and the average electric usage for Oncor customers overall, including customers with advanced and electromechanical meters.

a) Oncor Matched Complaint Comparison to Heating Degree Days

Our analysis included a comparison of the average monthly historical electric usage of the 951 matched complaints from customers with advanced meters in Oncor’s service territory (both pre and post-installation of the advanced meters) in comparison to the number of heating degree days during the winter months (i.e., December, January and February) from 2005 to 2010.

Figure 63 displays a graph comparing the average monthly electric usage for customers with complaints and advanced meters to the number of heating degree days before and after advanced meters were installed.

*Average electric usage correlates to increases and decreases in heating degree days throughout the period.*

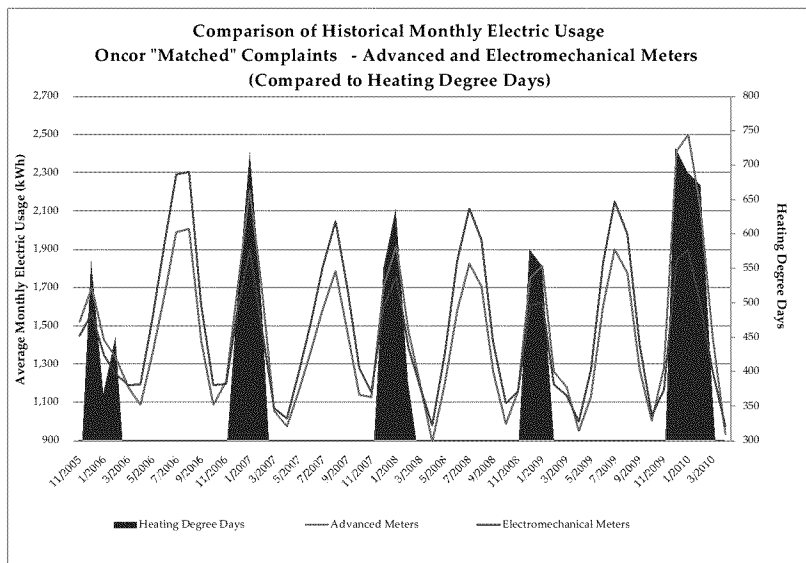


b) Oncor Matched Complaint Comparison (Advanced vs. Electromechanical)

We also compared the historical electric usage patterns for customers with advanced meters and complaints to customers with electromechanical meters. Of the 3,018 Oncor matched complaints, 951 were complaints where an advanced meter was in use and 2,067 were complaints where an electromechanical meter was in use. Our objective was to determine if the average electric usage of customers with advanced versus electromechanical meters was significantly different.

Figure 64 compares the average monthly electric usage for customers with complaints and advanced meters to customers with electromechanical meters.

*Trends in average monthly electric usage for customers with advanced meters were not significantly different from customers with electromechanical meters, and relative to heating degree days.*





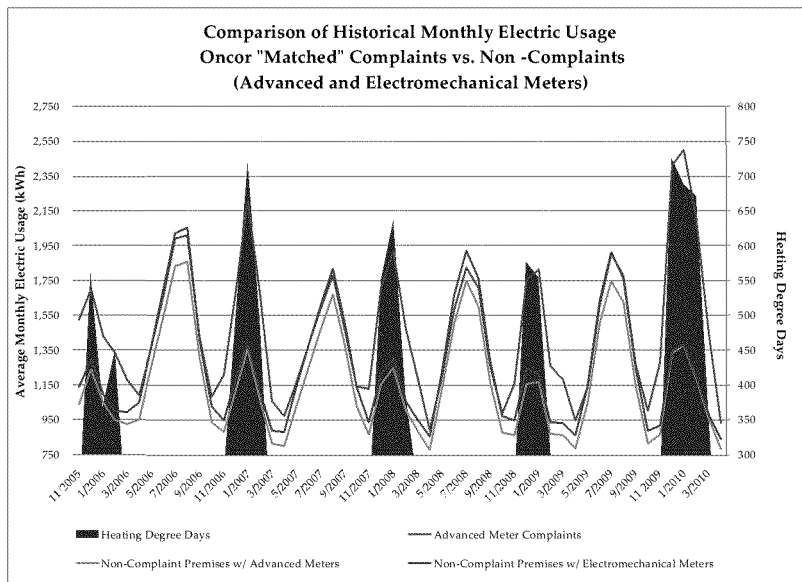
The correlation between customers with advanced meters and those with electromechanical meters appears relatively consistent from one year to the next. Customers with advanced meters in our sample on average consume more energy in winter months, and lower in summer months, than customers with electromechanical meters. While the observed peak average electricity usage was slightly higher this past winter relative to usage peaks in prior periods, it does not appear to be inconsistent with the observed trends. Further correlation to heating degree days, as well as comparison to the 2006 / 2007 winter, supports the conclusion that **the observed average increase in electricity usage during the past winter in Texas was primarily due to the severity of the winter in Texas and the significant increase in heating degree days.**

c) Oncor Matched Complaint Comparison to All Other Meters

We also compared the average historical electric usage of the 951 Oncor customers with advanced meters and complaints to the average historical usage for all other customers with advanced meters (~510,000 customer premises) and a large population of customers with electromechanical meters (~293,000 customer premises) in the same or contiguous zip codes.

Figure 65 compares the average monthly electric usage for customer premises with advanced meters and matched complaints to the average monthly electric usage for other customer premises with electromechanical or advanced meters.

*The average electric usage for customers with matched complaints was consistent in comparison to other customers.*



While the average monthly electric usage for customers with advanced meters and complaints was generally higher than other customers with either electromechanical or advanced meters, the relationship (i.e., correlation) was relatively consistent from one period to the next. Of interest, during summer months the average electric usage is fairly consistent among the three (3) groups. However, in winter months customers with advanced meters and complaints on average used significantly more electricity by comparison, and this pattern is fairly consistent across each winter. The primary explanation is the difference in heating source (i.e., electric versus gas heat). As such, **it is likely that a significant number of customers who filed complaints with the Commission in early 2010 had an electric heating source (as opposed to heat fueled by natural gas or propane) and therefore experienced higher electric bills due to the severity of the past winter in Texas, consistent with the significant increase in heating degree days observed.**

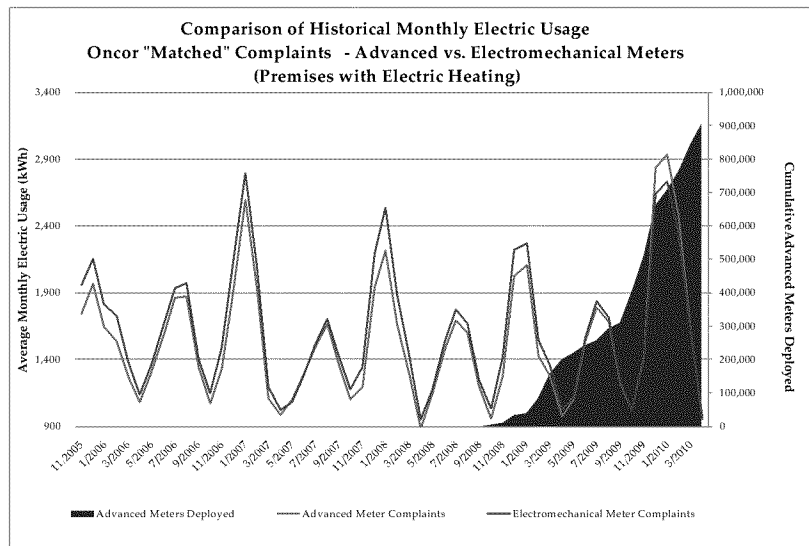
In addition, while there clearly is an increase in average electric usage in December, January and February 2009 / 2010 in comparison to prior winter seasons (approximately 25% from the peak in 2008/2009), much of that difference is explained by the increase in the number of heating degree days. As depicted earlier, the number of heating degree days increased from last year (2008/2009) to this year (2009/2010) by over 56%.

d) Oncor Matched Complaint Comparison by Type of Heating

To further analyze the matched complaints and the relative impact the type of heating source (gas vs. electric) may have had on the customer premises evaluated, we categorized each of the Oncor matched complaints by gas or electric heat and compared the historical average electric usage across the same time periods.

Figure 66 displays a graph of the historical average electric usage for customer premises in the matched complaints with primarily electric heating sources.

*The average electricity consumed from one period to the next is very consistent between the two (2) groups over time, with average electric usage for advanced meters edging higher in early 2010.*



While the average electric usage for customers with advanced meters edged higher than customer premises with electromechanical meters in early 2010 (relative to what it had been in prior winters), the consumption patterns and trends were fairly consistent over time. While our analysis does not answer all questions regarding the deployment and accuracy of advanced meters, the comparisons noted above support the conclusion that **there has been no significant difference in the amount of observed electric usage by customers as a result of the installation of advanced meters.**

e) Limitations of Analysis and Unexplained Variances

When analyzing average monthly electric usage over time many different types of events can affect the analysis. These events include different tenants at the customer premise (e.g., customer move-in and move-outs, etc.), structural changes to a residence (e.g., room additions, pool installations, etc.), heating and/or cooling source changes (e.g., change from gas to electric heat) and household demographic changes (e.g., increase or decrease in family size, change in appliances, etc.). Each of these events could have an impact on average monthly electric usage over time, and which could impact the results of the analysis referenced above.

3. Correlation of Oncor Matched Complaints to Heightened Media Coverage

While the focus of our analysis was in evaluating a potential correlation between increased , billing ' and , meter ' related complaints and the deployment of advanced meters, we also noted that other factors may have contributed to the number of complaints from customers with advanced meters received by the Commission. As such, we also evaluated the potential correlation of the timing of complaints to media coverage during the early part of 2010. Specifically, we noted a potential correlation between increased media coverage suggesting a potential link between the deployment of advanced meters and the increase in customer billing concerns.

Figure 67 includes quotes from select articles in the Dallas - Fort Worth area, as well as the Temple - Killeen area during January and February 2010.

"The recent cold weather has some North Texans seeing red over rising electric bills. But some customers are blaming new digital power meters for their increased electricity expenses."  
1/22/10 Dallas / Fort Worth NBC affiliate

"Some Dallas residents who already have 'smart' meters monitoring their power echo claims of higher electric bills. They believe the new meters are to blame, and they're fighting back."  
2/22/10 Dallas / Fort Worth ABC affiliate

"The new meter - Oncor's Smart Meter - has taken much of the blame from upset consumers." and "In instances like these, the PUC has a system by which consumers may file complaints."  
2/7/10 Killeen Daily Herald

"...city and state officials are urging their Central Texas constituents to be vocal about their electric bill frustrations."  
2/9/10 Killeen Daily Herald

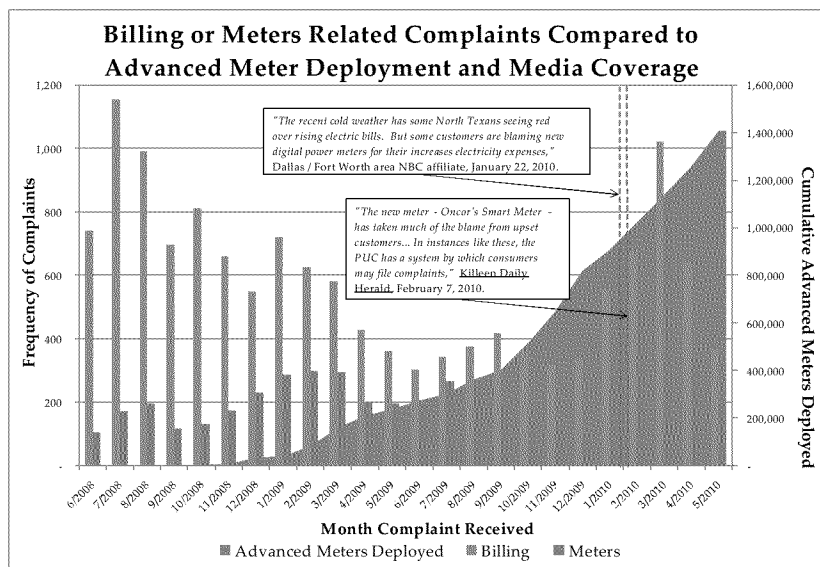
"Residents throughout the region have complained about escalating bills and say they believe the issue is tied to the new meters."  
2/10/10 Temple Daily Telegram

Media coverage suggesting a potential link between the deployment of advanced meters and higher electric bills began in parts of Oncor's service territory in early 2010.

The number of , billing ' related complaints filed with the Commission during February and March 2010 remained relatively consistent in comparison to the number of , billing ' related complaints in prior periods. However, the complaints categorized as , meter ' related complaints filed with the Commission increased significantly in February and March 2010 after the heightened media coverage.

Figure 68 includes a bar chart displaying the number of , billing ' and , meter ' related complaints submitted to the Commission each month during the January 2007 - May 2010 time period relative to the beginning of the media coverage.

The frequency of complaints increased significantly after the heightened media coverage.



4. Analysis of Specific Oncor Customer Concerns

Our evaluation included a detailed analysis of the specific billing concerns of 60 Oncor customers that had requested an independent third-party meter accuracy test. Our analysis entailed discussions with the identified customers and analysis of specific concerns raised in relation to certain observed increases in electric usage after the installation of an advanced meter.

We conducted initial discussions with each of the 60 customers during Field Testing of their advanced meters and followed-up with additional discussions regarding each customer's historical electric bills and associated concerns, as well as other general information regarding their residence and electric usage patterns.<sup>69</sup> The evaluation of each customer concern included analyzing their historical electric usage for the period before and after installation of their advanced meter, as well as comparison to prior period use and relative to the number of heating degree days.

Each customer concern was evaluated with respect to various factors to either help explain why customers may have experienced higher electric bills or to assist in identifying potential problems that may need to be addressed by Oncor in relation to its deployment and use of advanced meters. The various factors evaluated included the following:

- 1) The timing of the higher usage relative to when the customer received an advanced meter;
- 2) Comparison of the higher usage to average electric usage in prior periods;
- 3) Comparison of the higher usage to changes in weather (i.e., heating degree days);
- 4) Analysis of the higher usage relative to the length of the billing cycle in that period;
- 5) Evaluation of final ,out-reads' on electromechanical meters removed;
- 6) Evaluation of ,estimated' reads where actual reads were unavailable;
- 7) Evaluation of ,manual' reads either before the meter was provisioned and approved for use or if automated reads on the advanced meter were unavailable; and
- 8) Evaluation of the impact of potential changes in the customer's REP or electric rates.

Based on the results of our analysis, we noted that each of the specific customers had a significant increase in at least one month of their electric usage. In addition, we noted that almost all concerns related to increased usage in the December 2009 and January and February 2010 time periods. Further, while some customers had received an advanced meter in early 2009, many received an advanced meter around the same time period of the observed increase in electric usage.

The advanced meters for each of these customers was tested for accuracy and found to be accurate within the guidelines set by the Commission.

<sup>69</sup> Of the 60 customers expressing interest in a detailed review of their advanced meter concerns, we were able to contact 48 customers by telephone to conduct additional follow-up discussions. For the 12 customers unable to be contacted, three (3) attempts were made to reach the customer over a five (5) day period. Approximately 43 of the customers contacted offered to send copies of past electric bills to provide additional information for our review.

Based on the results of our analysis, and with the benefit of information related to the installation dates for the advanced meters in question, as well as the current and prior period electric usage (including prior years), **we observed that in most cases the observed higher electric usage for these customers could be explained.**

In some cases, the customer's higher electric usage was before the installation of an advanced meter. In others, the customer's usage (while significantly higher than previous months) was not inconsistent with usage in prior years. Still in others, even though usage was higher than both previous months and during the same periods in prior years, the increased usage was not inconsistent with the expected increase in usage as a result of the significant increase in heating degree days associated with the recent severe Texas winter.

However, there were instances where customers appear to have been billed based on either estimated or manual reads (not automated reads from the advanced meter) that appear to have been inconsistent with the customer's actual usage. Such reads would typically lead to either lower or higher billed usage in one month and then higher or lower billed usage in the subsequent month, respectively. These instances were reported to Oncor and appear to ultimately have had no impact on the customer (e.g., if the estimated read was too low, the actual read in the following month would 'true-up' to account for the difference in actual usage.)

For purposes of our investigation, the 60 Oncor customers with billing concerns were categorized into the following areas based on the current status of our analysis and observations:

- **Higher Usage Occurred Before Installation of the Advanced Meter** – concerns that appear to be based on electric usage and bills before the installation of the customer's advanced meter.
- **Usage Consistent with Prior Periods** – concerns regarding electric usage that does not appear to be inconsistent with the customer's electric usage in prior periods.
- **Usage Consistent with Prior Periods Relative to Heating Degree Days** – concerns where there may have been a difference between the customer's electric usage in current and prior periods but not inconsistent relative to cooling or heating degree days.
- **Usage Consistent with Prior Periods and Differences in Billing Cycle** – concerns where there may have been a difference between the customer's electric usage in current and prior periods but not when adjusted for differences in length of billing cycle.
- **Inconsistency in Usage Due to Inaccurate Estimated Read** – concerns where there appears to be an inconsistency in electric usage from one period to the next that resulted from an inaccurate estimated read of the advanced meter.
- **Inconsistency in Usage Due to Inaccurate Manual Read** – concerns where there appears to be an inconsistency in electric usage from one period to the next that resulted from an inaccurate manual read of the advanced meter.
- **Customer was New to the Premise** – concerns from customers in a relatively new premise and where no basis exists to evaluate their usage relative to prior period usage.

A summary of our observations is provided in *Table 16* below.

Description	# of Customers	%
Higher Usage Occurred Before Installation of the Advanced Meter	3	5
Usage Consistent with Prior Periods	26	43
Usage Consistent with Prior Periods Relative to Heating Degree Days	18	30
Customer was New to the Premise	6	10
Usage Consistent with Prior Periods and Differences in Billing Cycle	2	3
Inconsistency in Usage Due to Estimated Read	3	5
Inconsistency in Usage Due to Inaccurate Manual Read	2	3
<b>Total</b>	<b>60</b>	<b>100%</b>

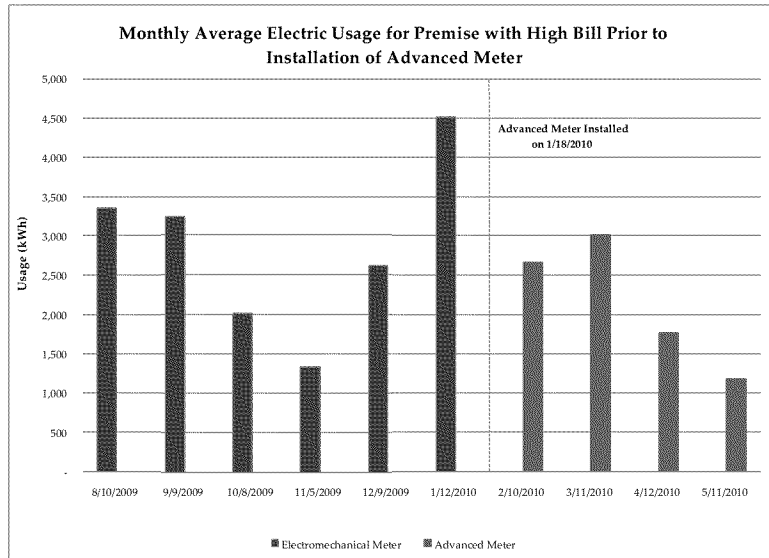
Provided below are several examples for some of the observed higher monthly electric usage experienced by certain customers in Oncor’s service territory.

a) High Bill Occurred Before Installation of the Advanced Meter

We observed several instances where a customer raised concerns about a higher electric bill around the time their advanced meter was installed. However, the observed higher electric usage appears to have occurred before the advanced meter was installed. While the possibility exists that the observed final read and bill on the electromechanical meter was inaccurate, further evaluation of the customer electric usage did not support that conclusion. An example is provided below.

*Figure 69* displays a bar chart depicting the billing history for a customer who received an advanced meter on January 18, 2010. The customer’s concern was in relation to a bill prior to the installation of the advanced meter.

*The final bill was also consistent with the customer’s prior period electric usage.*

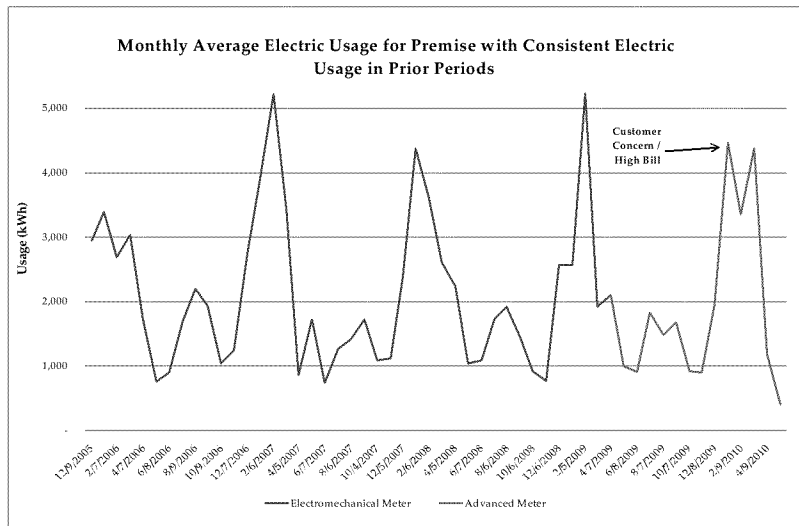


b) Usage Consistent with Prior Periods

We identified a number of instances where a customer’s observed increased electric usage during the period of concern was consistent or similar to the customer’s usage in prior periods.

Figure 70 provides an example of the monthly electric usage for a customer with a concern about their high electric usage in early 2010. The red and blue lines represent usage related to the electromechanical and advanced meter respectively.

*The average monthly electric usage for the period related to the customer concern is consistent with electric usage in prior periods.*



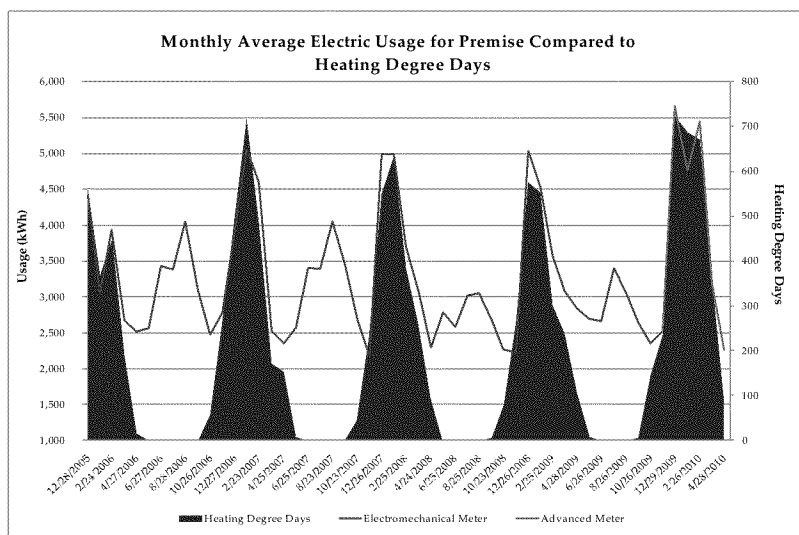
In some cases, the observed higher electric bills occurred during the month the advanced meter was installed. We compared the portion of the billing period with an electromechanical meter to the portion of the billing period with an advanced meter noting, in several other instances, that average consumption (kWh) per day was consistent across both types of meters during the month.

c) Usage Consistent with Prior Periods Relative to Heating Degree Days

We also identified a number of instances in which the observed higher electric usage was consistent with prior period usage when correlated to the number of heating degree days.

Figure 71 provides an example of the monthly electric usage for a customer compared to the number of heating degree days. The red and blue lines represent usage related to the electromechanical and advanced meter respectively.

*The electric usage for the period in question is similar to electric usage in prior periods relative to the heating degree days.*

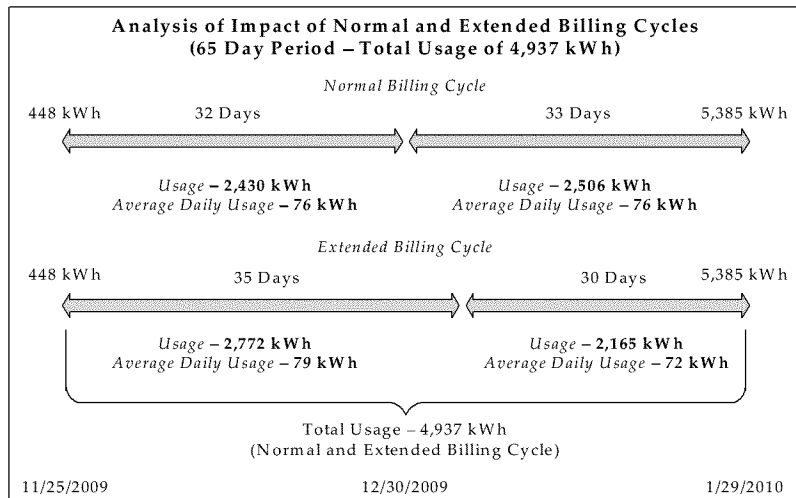


d) Usage Consistent with Prior Periods and Differences in Billing Cycle

We observed several instances where the length of the customer’s billing cycle in a particular month resulted in the perceived increase in electric usage. It is not uncommon for certain billing cycles to extend beyond the standard 30 days most customers expect (e.g., some up to 35 days). As a result, certain bills may appear artificially high (e.g., 35 days) and others low (e.g., 28 days).

Figure 72 illustrates that an extended billing cycle during a 65-day billing period could produce two (2) very different customer bills.

*While total usage for the 65-day period is the same, the electric usage for the individual billing periods differs by almost 30%.*

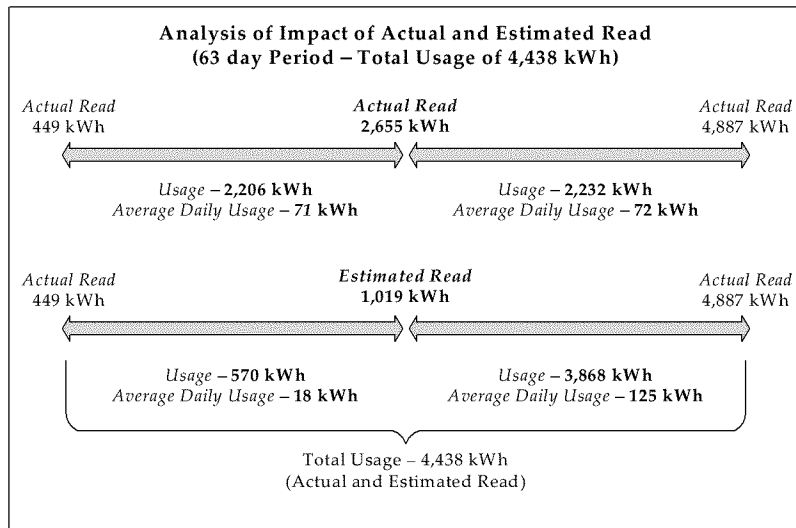


e) Inconsistency in Usage Due to Inaccurate Estimated Read

We identified several examples where the bills in question were estimated bills. Bill estimation is fairly uncommon and the incidence of estimated bills is expected to decline as more advanced meters are deployed. However, when a bill is estimated the electric usage on the bill may not reflect the actual usage. As a result, subsequent bills would be adjusted up or down to reflect (i.e., true-up) the actual cumulative usage at that point in time. A bill that underestimates usage would result in a lower bill than expected that month and higher bill than expected in the next month.

Figure 73 illustrates the effect of an estimated read on each billing period where the total electric usage over a 63-day period is the same.

*While total usage for the 63-day period is the same, usage for the individual billing periods is different due to the estimated read, which caused an artificially low bill in one period and a higher bill in the next (due to the correction or “true-up”).*



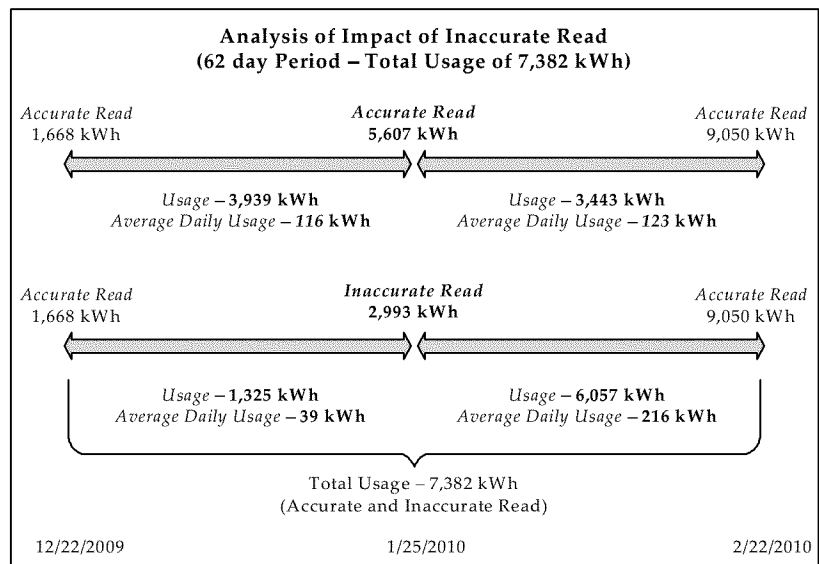


f) Inconsistency in Usage Due to Inaccurate Manual Read

Our detailed analysis of customer concerns also resulted in the identification of instances where it appears that an inaccurate manual read on an advanced or electromechanical meter resulted in an increase in the observed electric usage for the bill in question. Electromechanical meters were manually read (a final ,out-read ') at the time of the installation of the advanced meter. In addition, advanced meters could be manually read if the meter had not been ,provisioned' in the advanced metering data system or if it was not communicating data back to the system for any reason. Similar to an estimated bill, if the manual meter read was incorrect and the actual electric usage was higher than the incorrect manual read, the subsequent month's bill would be higher since it would effectively be including usage for the current month and the prior month due to the correction or 'true-up'.

Figure 74 illustrates the effect of an inaccurate read on each billing period where the total electric usage over a 62-day period is the same.

*While total electric usage for the 62-day period is the same, the electric usage for the individual billing periods is different due to the inaccurate read causing artificially high and low electric usage for each individual billing period.*



g) Customer was New to the Premise

We identified a number of examples in which the customer moved into the premise within 12 months preceding the high bill. A comparison to the percentage increase from the previous winter was not relevant because the previous winter reflected the consumption habits of a different resident. In other cases, the residence was built within 12 months of the observed higher electric usage and this past winter was the first winter in which consumption was recorded for the premise. In either case, the customer had relatively little history with Oncor at the specific premise (i.e., location) upon which to base our evaluation.

**IX. Meter Data Management Process and Controls Review**

**A. Background**

As described previously, one of the many advantages of advanced meters is their ability to provide electric consumers, and the TDSPs and REPs who serve them, with current or near real-time information regarding electricity consumption. Unlike an electromechanical meter that has on average one (1) meter read or data point associated with it per month for billing purposes an advanced meter has over 2,900 meter reads or data points per month (i.e., up to 3 register reads and 96 interval reads per day). Managing this large amount of information requires a robust advanced metering data management system that has the ability to accurately measure, record and transmit information from the advanced meters to the TDSPs, as well as the ability to process and validate information and subsequently transmit it to ERCOT and the REPs (for billing purposes).

**B. Scope of Work**

Navigant Consulting conducted an evaluation of each TDSP’s advanced metering system including a review of the advanced metering infrastructure, an evaluation of the advanced meter data management process and associated controls, and an analysis to determine if the electricity consumption (i.e., usage) information is transmitted correctly from the advanced meter to the advanced metering system and ultimately for provision to the REPs for billing purposes.

**C. Work Performed**

1. Advanced Metering Infrastructure (AMI) Review

Navigant Consulting reviewed the advanced metering system infrastructure of each TDSP to evaluate whether the advanced metering systems in place were sufficient to meet the requirements associated with the advanced meter deployment plan of each TDSP. We identified a number of core components that are common across each TDSP including the following:

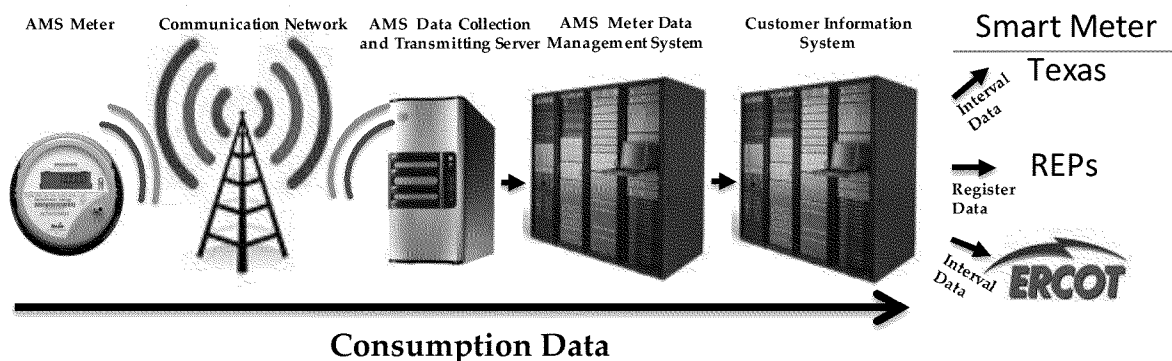
- *Advanced Meters* – devices that measure, record, store and transmit electricity consumption data for the premise;
- *Routers and Collectors* – communication network devices that facilitate the transmission of electricity consumption data from the meters and collects the data for transmission to the TDSP in batches;
- *Head End System* – software system that collects the batches of electricity consumption data and organizes the data for further processing;
- *Meter Data Management System (“MDMS”)* – software system that validates the electricity consumption data and conducts any estimating and editing that may be required to complete any incomplete electricity consumption data sets; and
- *Customer Information System (CIS)* – software system that contains specific information regarding the customer and premise, as well as electricity consumption data utilized for billing purposes.

Advanced meters produce two (2) types of electricity consumption data that is recorded and transmitted through the advanced metering system infrastructure. The two (2) types of data include:

- *Register Read Data* – Electricity consumption measured on a daily basis that is used by REPs for billing purposes.
- *Interval Read Data* – Electricity consumption measured individually for each 15 minute period that is used by ERCOT for settlement purposes.

Our evaluation of the advanced metering infrastructure focused primarily on the systems and processes relating to the communication of register read data from the advanced meters to the advanced metering system. *Figure 75* below depicts the infrastructure of a typical advanced metering system and illustrates the relationship of the various components, as well as the information that is stored and / or transmitted through each of the components.

**Figure 75. High-Level Data Flow in Typical Advanced Metering Systems**



## 2. Advanced Meter Data Management Processes and Associated Controls Review

We conducted an evaluation of the established advanced meter data management processes and associated controls within the advanced metering infrastructure at each TDSP. This analysis was designed to ensure that the processes and controls established at each TDSP related to the transmission of electricity consumption data through the advanced metering infrastructure are sufficient. We conducted interviews with key TDSP employees, evaluated existing internal process and control documentation related to each TDSP’s meter data management system, and developed process maps that traced the flow of data through the advanced metering system and identified and evaluated control points for each TDSP.

We also reviewed exception reports generated by the different advanced metering data systems for each TDSP and the associated processes for resolving the identified exceptions. We conducted interviews with TDSP personnel related to the exception reports and associated resolution process and observed the execution of the manual data verification activities conducted by employees responsible resolving the exceptions. This evaluation provided an in-depth understanding of the processes and controls related to the management of the meter data at each of the TDSPs.

3. Meter-to-Bill Data Analysis

The evaluation also included a detailed analysis of the register read data communicated from the advanced meters through the advanced metering system at each of the TDSPs (, Meter-to-Bill Analysis'). The Meter-to-Bill Analysis was designed to provide reasonable assurance that the register read and interval data recorded by the advanced meter is transmitted correctly from the meter to the advanced metering system for ultimate use by the REPs in billing customers and ERCOT in settling the wholesale market. The analysis included identifying and obtaining register read and interval data from the advanced meter and at various points in the advanced metering system. The analysis also included evaluating the effectiveness of the communication of the register read and interval data from the advanced meter through the advanced metering system and verifying that the register read and interval data was transmitted correctly.

a) Identification and Acquisition of Register Read and Interval Data

(i) Acquisition of Register Read and Interval Data from Advanced Meters

We obtained register read and interval data directly from advanced meters for use in the Meter-to-Bill Analysis. During the Meter Exchange Process described in Section V of this Report, Navigant Consulting and/or TDSP personnel downloaded a meter profile and load profile report from each advanced meter using an optical probe. We obtained historical register read and interval data directly from 263 Oncor, 159 CenterPoint, and 32 AEP Texas advanced meters.<sup>70</sup>

(ii) Acquisition of Register Read and Interval Data from AMS

We also obtained and analyzed register read and interval data during the Meter-to-Bill Analysis for 1,300 Oncor advanced meters, 1,084 CenterPoint advanced meters and 96 AEP Texas advanced meters based on the ,Deployed' meters tested during the Bench Testing portion of our evaluation. The register read and interval data was obtained from various points in each TDSP's advanced metering system including the Head End system, MDMS and the CIS for a selected time period.<sup>71</sup>

**Table 17** summarizes the sources of the register read and interval data obtained from each TDSP.

Sources of Register and Interval Data Obtained			
	Oncor	CenterPoint	AEP Texas
# of Meters	1,300	1,084	96
Data Systems	Head End / IODS MDM / AODS LCIS	MDM CIS	Head End MDM CIS
Other Information	N/A	MRI /MRE File Market Transaction Report	Smart Meter Texas Portal File
Time Period	October 2009 - May 2010	October 2009 - April 2010	May 22 – May 25, 2010

<sup>70</sup> Register read and interval data was not obtained from all meters evaluated in the Meter-to-Bill Analysis due to the complexity and level of effort required to gather information directly from advanced meters.

<sup>71</sup> We did not analyze data from CenterPoint's DCE (Head End system). CenterPoint's DCE operates a ,pass-through' and does not store register read or interval data.

b) Meter-to-Bill Analysis of Register Reads and Interval Data

(i) *Evaluation of Advanced Metering System Communication Effectiveness*

The Meter-to-Bill Analysis included an evaluation of the effectiveness of the communication between the advanced meter and advanced metering system, as well as within the advanced metering system. We analyzed the number of automated register reads successfully communicated from the advanced meters that went through the advanced metering system relative to the number of register reads that were either estimated or required a manual meter reading. An automated register read would not be communicated successfully if the advanced meter was unable to communicate and transmit data to the Head End. An inability to communicate with the Head End would be evidenced by an estimated or manual register read in the MDMS or CIS. Utilizing certain information provided from each TDSP including various system codes, we identified the number of automated register reads, as well as the number of estimated or manual register reads from provisioned advanced meters in the MDMS and CIS.<sup>72</sup>

(ii) *Verification of Register Reads through Advanced Metering System*

The Meter-to-Bill Analysis also included the verification of register reads communicated from the advanced meter through the advanced metering system for each of the TDSPs. Specifically, we traced the daily and monthly register reads from the advanced meter to the Head End system, from the Head End system to the MDMS, and from the MDMS to the CIS to provide reasonable assurance that the daily and monthly register read information was communicated accurately.

c) Meter to Back-End System Verification Analysis (On-Demand Read)

During the Meter Exchange process conducted in the Oncor, CenterPoint and AEP Texas service territories and the Field Testing process conducted in the Oncor service territory, Navigant Consulting personnel completed a Meter-to-Back-End System Verification Analysis (On-Demand Read) for approximately 657 advanced meters to test the ability of the TDSPs to accurately read advanced meters remotely. To complete an On-Demand Read during the Meter Exchange or Field Testing processes, Navigant Consulting personnel in the field telephoned one of several designated TDSP analysts, provided the TDSP analyst with the advanced meter serial number associated with the premise and recorded the remote register read provided by the analyst. We then recorded the register read displayed on the advanced meter and compared the manual read to the On-Demand Read.

**D. Observations and Conclusions**

1. Advanced Metering Infrastructure (AMI) Review

As described, Navigant Consulting's evaluation included an analysis of the advanced metering system infrastructure of each TDSP. We determined that the advanced metering systems currently

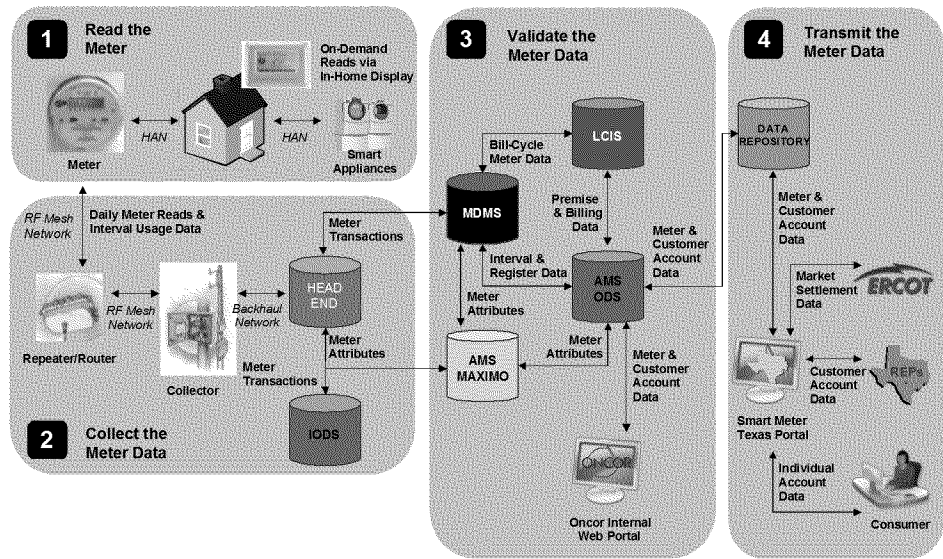
<sup>72</sup> The Oncor and AEP Texas Head End systems were not analyzed because they do not estimate register reads or interval data. AEP Texas' MDMS also does not generate estimated register reads.

in place, as well as planned system updates and upgrades, were sufficient to meet the requirements associated with the advanced meter deployment plan of each TDSP. The sections below describe in detail the advanced metering system architecture including the relevant devices and software systems (collectively ,components') utilized by each TDSP as well as an overview of each TDSP's advanced metering system deployment.

a) Oncor's Advanced Metering System Infrastructure and Deployment

Oncor's advanced metering system includes a number of core components that interact and communicate to validate and transmit electricity consumption information from the advanced meters through the advanced metering system.

Figure 76 provides a high level summary of Oncor's advanced metering system architecture.



Information related to each of the major components in Oncor's advanced metering system is detailed in the table below including information related to the manufacturer or provider of the system component, the number of components in service, and information regarding the operations and function of each meter system component.

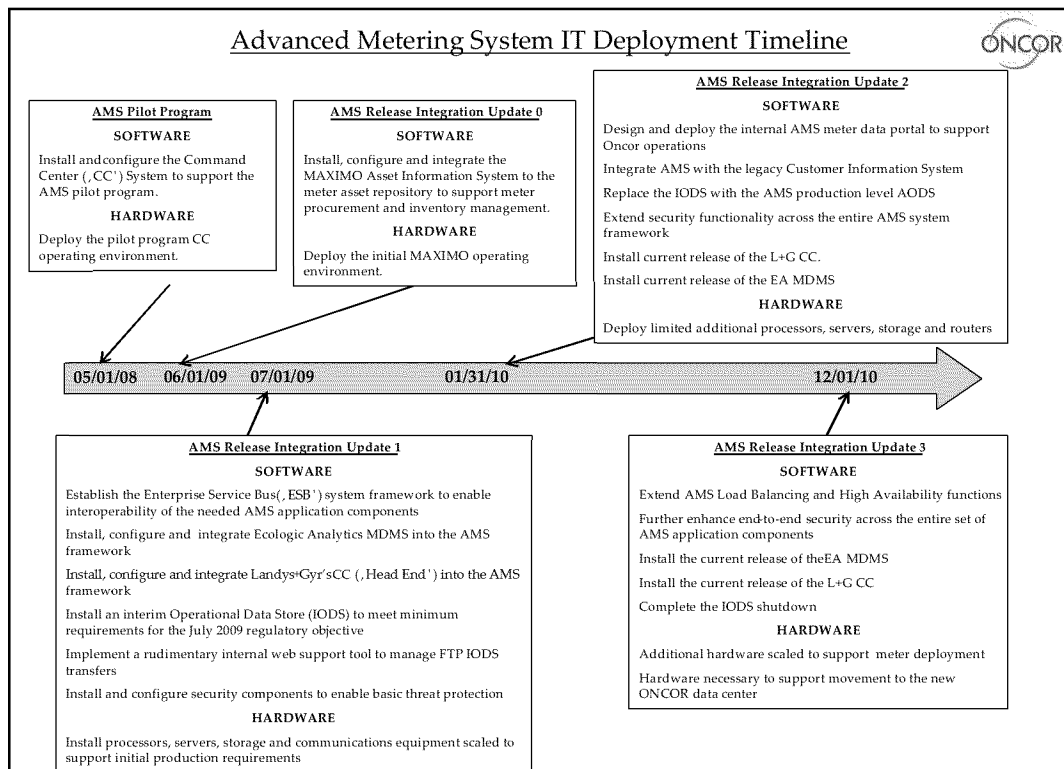
Table 18: Oncor Advanced Metering System Components

System Component	Manufacturer/ Provider	Number Deployed (May, 2010)	Function and Operations
Meters	Landis+Gyr	996,151	,FOCUS AXR' advanced meters record electricity consumption data and send it to RF Mesh Routers.
RF Mesh Routers	Landis+Gyr	2,983	Receive data from advanced meters and sends data to RF Mesh Collectors.
RF Mesh Collectors	Landis+Gyr	142	Receive data from RF Mesh Routers and sends it to Meter Head End System.
Meter Head End System	Landis+Gyr	1	Receives data from RF Mesh Collectors, converts meter pulse information to meter engineering units

IX. Meter Data Management Process and Controls Review

(, Command Center')			(kWh) and sends meter data to Meter Data Management System.
Meter Data Management System	Ecologic Analytics	1	Receives data from Meter Head-End System, performs validation and estimation processes on electricity consumption information and sends billing files to the Customer Information System.
Customer Information System (, LCIS')	Oncor	1	Receives billing files from Meter Data Management System and applies customer information associated with ESIID (i.e., specific meter premise).
Billing Engine (resident within LCIS)	Oncor	1	Generates electricity consumption data files for ERCOT and REPs, performs bill validation and estimation processes, submits invoices (for delivery charges only) to REPs and sends data to AMS Operational Data Store.
AMS Operational Data Store	Oracle Tables	1	Receives data from LCIS and transmits LSE formatted files to Smart Meter Texas portal.
Meter Asset Registry (Maximo)	IBM	1	Manages the meter asset information.

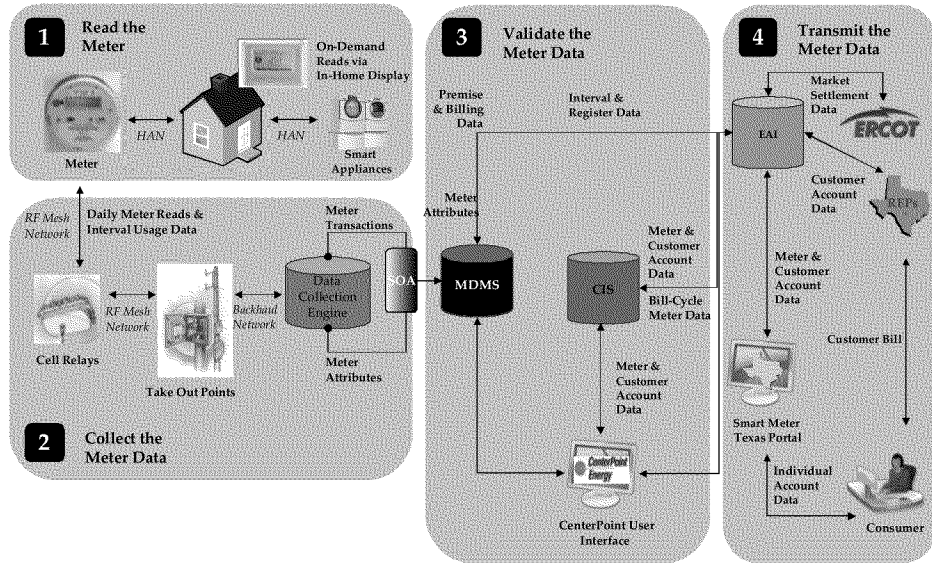
Our evaluation also included a review of certain firmware and technical upgrades performed on the advanced meters, as well as hardware and software system updates and upgrades. *Figure 77* provides an overview of Oncor’s advanced meter system deployment including information related to various advanced meter and system updates and upgrades, as well as an overall summary of the advanced metering system deployment to date.



b) CenterPoint's Advanced Metering System Infrastructure and Deployment

CenterPoint's advanced metering system includes a number of core components that interact and communicate to validate and transmit information from the advanced metering system.

Figure 78 provides a high level summary of CenterPoint's advanced metering system architecture.



Information related to each of the major components in CenterPoint's advanced metering system is detailed in the table below including information related to the manufacturer or provider of the system component, the number of components in service, and information regarding the operations and function of each system component.

Table 19: CenterPoint Advanced Metering System Components

System Component	Manufacturer/ Provider	Number Deployed (May 31, 2010)	Notes
Meters	Itron	397,136	, Centron Open Way version HW 2.0, SR 2.0, FW 5.0' advanced meters record electricity consumption data and send it to Cell Relays.
Cell Relays	Itron	1,444	Receive data from advanced meters and send it to Take Out Points (i.e., collectors).
Take Out Points	GE	40	Receive data from Cell Relays and send it to the Data Collection Engine.
Data Collection Engine (, DCE')	Itron	1	Receives data from Take Out Points and sends it to the Meter Data Management System.
eIP (Meter Data Management System – , MDMS')	eMeter	1	Receives data from the DCE, performs data validation, converts meter pulse information to meter engineering units (kWh) and sends data to the Customer Information System.
Customer	CenterPoint	1	Receives data from the MDMS, applies customer

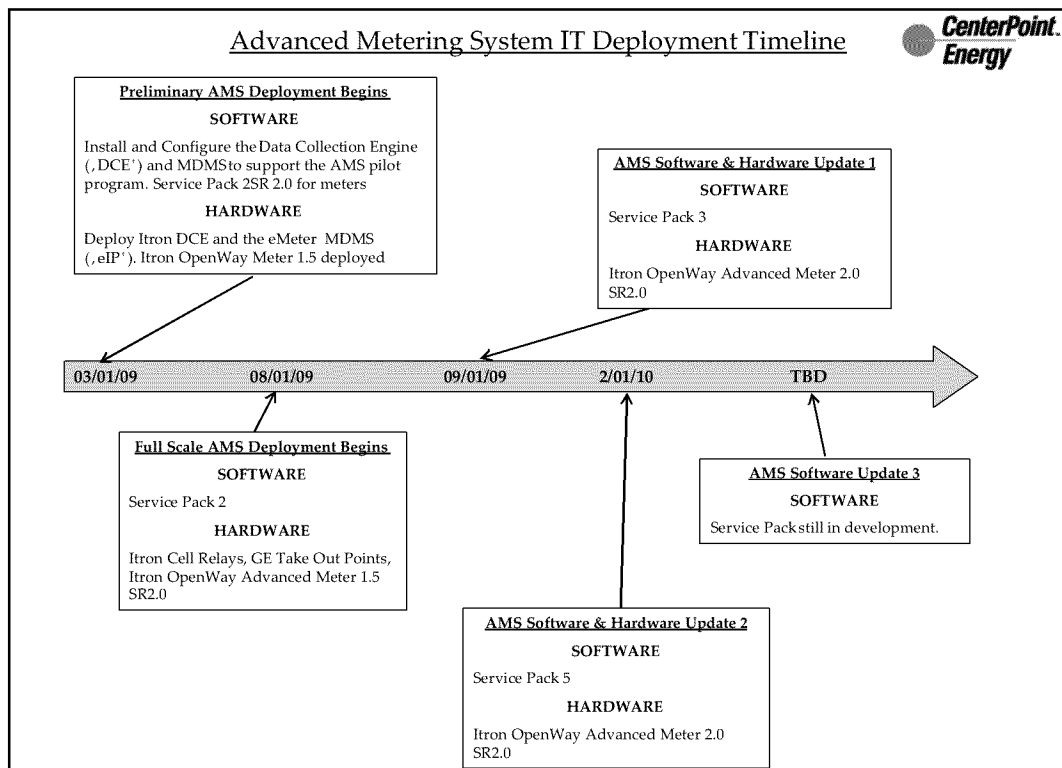


IX. Meter Data Management Process and Controls Review

Information System (CIS)			information associated with ESIID (i.e., specific meter location), performs bill validation and estimation processes, submits invoices (for delivery charges only) to REPs, and sends data to EAI.
EAI	SUN Java Caps	1	Receives data from the CIS and translates and transmits LSE formatted files to ERCOT, REPs, and Smart Meter Texas portal.
Meter Test Database (WECO)	Watt Hour Engineering (WECO)	1	Manages meter test data.

Our evaluation included a review of certain firmware and technical upgrades performed on the advanced meters, as well as hardware and software system updates and upgrades.

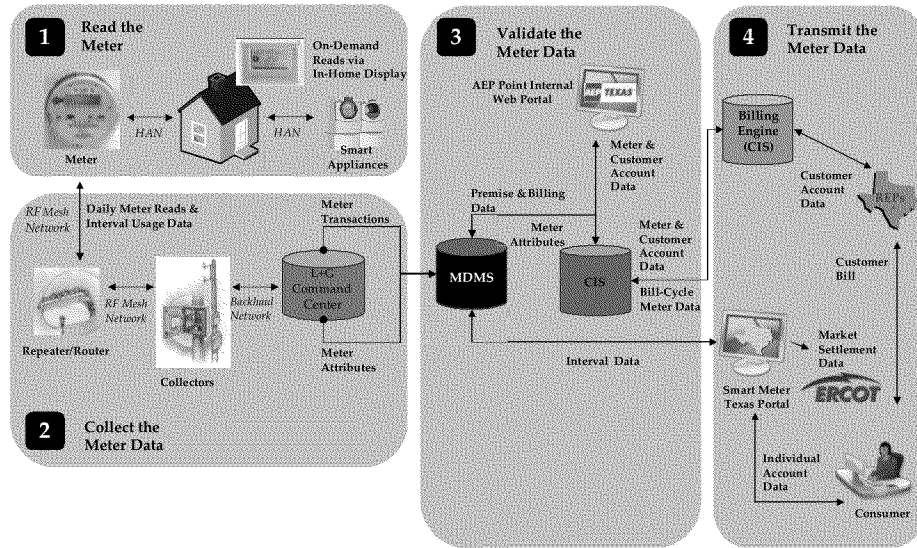
Figure 79 provides an overview of CenterPoint’s advanced meter system deployment including information related to various advanced meter and system updates and upgrades as well as an overall summary of the advanced metering system deployment to date.



c) AEP Texas’ Advanced Metering System Infrastructure and Deployment

AEP Texas’ advanced metering system includes a number of core components that interact and communicate to validate and transmit electricity consumption information from the advanced meters through the advanced metering system.

Figure 80 provides a high level summary of AEP Texas' advanced metering system architecture.



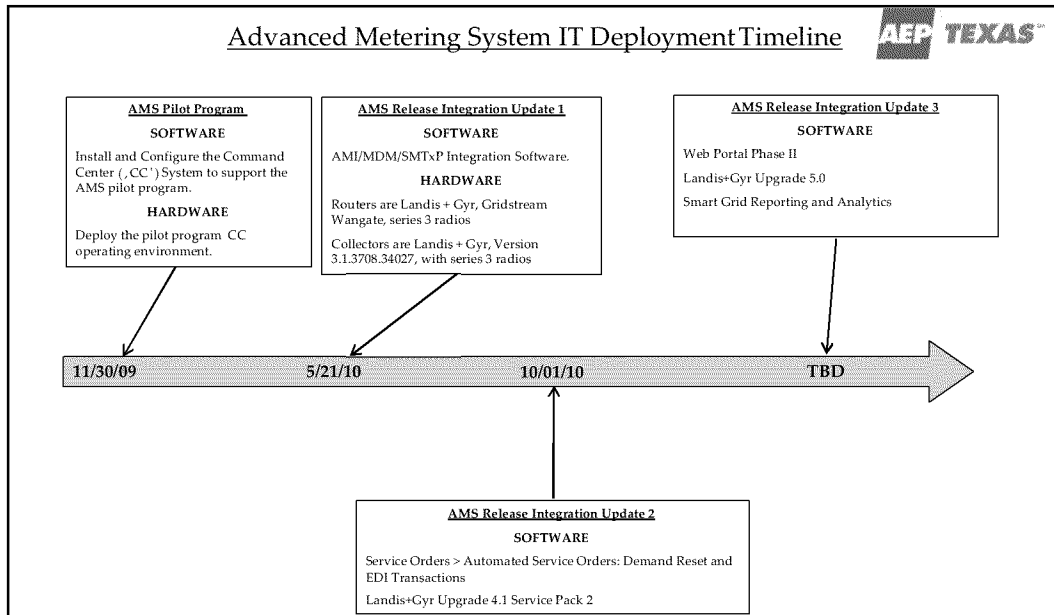
Information related to each of the major components in AEP Texas' advanced metering system is detailed in the table below including information related to the manufacturer or provider of the system component, the number of components in service, and information regarding the operations and function of each system component.

Table 20: AEP Texas Advanced Metering System Components

System Component	Manufacturer/ Provider	Number Deployed (May 2010)	Notes
Meters	Landis+Gyr	16,278	, FOCUS AXR' advanced meters record electricity consumption data and send it to RF Mesh Routers.
RF Mesh Routers	Landis+Gyr	51	Receive data from meters and send it to RF Mesh Collectors.
RF Mesh Collectors	Landis+Gyr	6	Receive data from RF Mesh Routers and send it to the Meter Head End System.
Meter Head End System (, Command Center')	Landis+Gyr	1	Receives data from RF Mesh Collectors, converts meter pulse information to meter engineering units (kWh) and sends meter data to Meter Data Management System.
Meter Data Management System (MDMS)	Oracle	1	Receives data from Meter Head-End System, performs validation and estimation processes on electricity consumption information, sends billing files to the Customer Information System (MACSS) and transmits LSE formatted files to Smart Meter Texas portal.
Customer Information System (CIS)	AEP	1	Receives billing files from Meter Data Management System and applies customer information associated with ESIID (i.e., specific meter location).
Billing Engine (resident within CIS)	AEP	1	Generates electricity consumption data files for ERCOT and REPs, performs bill validation and estimation processes, submits invoices (for delivery charges only) to REPs, and sends data to AMS REPs for billing.

Our evaluation also included a review of certain firmware and technical upgrades performed on the advanced meters, as well as hardware and software system updates and upgrades.

Figure 81 provides an overview of AEP Texas’ advanced metering system deployment including information related to various advanced meter and system updates and upgrades, as well as an overall summary of the advanced metering system deployment to date.



2. Advanced Meter Data Management Processes and Associated Controls Review

Navigant Consulting’s evaluation was designed to provide reasonable assurance that each TDSP has established processes and the appropriate level of controls sufficient to ensure that the transmission of electricity consumption data through the advanced metering infrastructure is accurate. The sections below describe the advanced meter data management processes and associated controls that were evaluated for each of the TDSPs.

a) Oncor’s Advanced Meter Data Management Processes and Controls

Oncor’s meter data management process utilizes data that flows from the advanced meter to the REPs for customer billing. Navigant Consulting reviewed the process to verify how electricity consumption data flowed from the advanced meter to the final transfer of data to the REPs. A process map that summarizes the advanced meter data management process and associated control points is attached as *Exhibit 15, ‘Oncor Meter Data Management Process Map.’* Detailed information related to each control point in the meter data management process is included below.

- 1) **Meter Communications Report** - After the meter initially communicates with the Head End after initial installation, Oncor begins monitoring a report that indicates if the advanced meters are communicating with the network and providing data to the Head

End. It may take several days or weeks for an advanced meter to begin communicating with the Head End depending on the status of the advanced meter mesh network deployment (although typically meters begin communicating with the Head End within a matter of minutes after installation). Advanced meters continue to be manually read until the route along which they are installed is complete. If an advanced meter is not communicating with the network in an area where other advanced meters are communicating with the network, it will be flagged for remediation. Once the meter has transmitted five (5) ,good' register reads to the Head End, the meter is ,provisioned' and billing based on automated reads will commence.

- 2) **Command Center Validations** – The Head End system applies a number of general data validation filters (e.g., Meter Time Sync Issue, Unexpected Usage on Disconnected Meter; and Daily Usage and Demand Threshold Alerts) to identify any abnormal electricity consumption data received from the advanced meters. Any invalid electricity consumption data is not transmitted to the MDMS. Oncor addresses any issues that are identified through the data validation process in the Head End system.
- 3) **MDMS “Critical” Validations** – The MDMS applies a number of ,critical' data validation filters (e.g., Usage on an Inactive Meter; Meter Identification Invalid; Invalid Date/Time; Verify Stop Date/Time is Greater than Start Date Time; and Invalid Unit of Measure) to identify any invalid electricity consumption data received from the Head End system. Any invalid electricity consumption data is not processed by the MDMS. Oncor addresses any issues that are identified through the ,critical' data validation process in the MDMS.
- 4) **MDMS “Usage” Validations** – The MDMS also applies a number of ,usage' data validations filters (e.g., Spike Check, High/Low Usage Check; Sum Checks; Zero Consumption) while the electricity consumption data is processed and validated to identify any abnormal fluctuations in the data. Electricity consumption data that is not validated is analyzed, corrected and resubmitted into the system. Oncor addresses any issues that are identified through the ,usage' data validation process in the MDMS.
- 5) **SMTxP Validations** – Multiple data validation filters relating to meter; premise; retailer of record; and monthly usage are applied prior to submission of the electricity consumption data to the Smart Meter Texas portal to ensure that the electricity consumption data is attributed to the appropriate meter, premise, and REP. Oncor addresses any issues that are identified through the data validation process prior to submission to the Smart Meter Texas portal.
- 6) **LCIS Validations** – The CIS applies multiple data validation filters (e.g., Read Date Not Equal To Current Date; kWh Failed Hi-Limit Check; kWh Equals Zero; Bill Data Not Available; Amount Greater Than \$300; and Average Demand Exceeds 500kW) to evaluate the electricity consumption data acquired from the MDMS during the monthly billing process. Oncor Texas addresses any billing related issues as they are identified.

- 7) **Meter Service Multiplier Validations** – The meter asset registry ‘MAXIMO’ validates that the correct multiplier has been applied to each consumption records prior to REP billing.

Navigant Consulting found that many of Oncor’s meter data management processes and systems meet the standards of organization and operation expected of a large TDSP. However, certain inconsistencies and process gaps were noted in relation to the effective monitoring of advanced meter performance and meter communication related issues that resulted in certain meter related failures going unnoticed for longer periods of time than they should have. Many of the issues are described in Section X of this Report. An assessment of the adequacy of the other control points associated with the meter data management process is included in *Table 21* below.

**Table 21: Oncor Advanced Meter Data Management Process Control Points**

No.	Control Point Owner	Description	Assessment
1)	Oncor	<b>Meter Communications Report</b> – Advanced meters are monitored for consistent communication with the Head End on a daily basis.	Control point adequately verifies that advanced meters are consistently transmitting electricity consumption data.
2)	Oncor	<b>Command Center Validations</b> – Electricity consumption data transmitted from the advanced meter is analyzed for abnormal or invalid data on a daily basis.	Control point generally ensures that valid electricity consumption data is transmitted from the advanced meter.
3)	Oncor	<b>MDMS “Critical” Validations</b> – Electricity consumption data transmitted from the Head End is analyzed for abnormal or invalid data on a daily basis.	Control point generally ensures that valid electricity consumption data is transmitted from the Head End.
4)	Oncor	<b>MDMS “Usage” Validations</b> – Electricity consumption data transmitted from the Head End is analyzed for abnormal or invalid data on a daily basis.	Control point generally ensures that valid electricity consumption data is transmitted from the Head End.
5)	Oncor	<b>SMTxP Validations</b> – Electricity consumption data transmitted from the MDMS is validated on a daily basis.	Control point generally ensures that electricity consumption data for each premise is accurately transmitted to the Smart Meter Texas portal.
6)	Oncor	<b>MACSS Validations</b> – Electricity consumption data transmitted from the MDMS is validated for customer billing purposes.	Control Point generally ensures that valid electricity consumption data is utilized for billing purposes.
7)	Oncor	<b>Meter Service Multiplier Validations</b> – The meter asset registry, ‘MAXIMO’ validates that the correct multiplier has been applied.	Control Point validates that the correct multiplier has been applied to each consumption records prior to REP billing.

b) CenterPoint's Advanced Meter Data Management Processes and Controls

We evaluated CenterPoint's advanced meter data management practices to provide reasonable assurance that the processes and associated controls utilized were sufficient to ensure that the electricity consumption data transmitted from the advanced meter through the advanced metering system and ultimately to the REPs for billing purposes is accurate. A process map that summarizes the advanced meter data management process and associated control points is attached as *Exhibit 16*, 'CenterPoint Meter Data Management Process Map.' Detailed information related to each control point in the meter data management process is included below.

- 1) **Route Acceptance Report Monitoring** – Itron monitors a route acceptance report that identifies advanced meters that are not communicating with the network or providing data to the DCE directly after installation. Advanced meters not communicating with the network over a three (3) day period are evaluated and replaced if the meter subsequently fails to re-establish communication. CenterPoint monitors the communications on a daily basis after responsibility for the performance and maintenance of the advanced meters is transferred (i.e., once the advanced meters are 'accepted and approved') from Itron to CenterPoint. CenterPoint begins analysis of any non-communicating advanced meter within 24 hours.
- 2) **DCE and MDMS Validations** – The MDMS applies nine (9) data validation filters to identify any abnormal fluctuations in electricity consumption data received from the DCE on a daily basis. The DCE also applies a data filter to identify certain event codes that could result in the transmission of incorrect electricity consumption data.<sup>73</sup> CenterPoint addresses any issues as they are identified.
- 3) **Advanced Meter Request Monitoring** – The CIS must acquire authenticated electricity consumption data (i.e., register reads) from the MDMS during the monthly billing process. CenterPoint addresses any unsuccessful attempts by the CIS to acquire authenticated electricity consumption data as they are identified.
- 4) **Fail-to-Bill Monitoring** – The CIS applies 61 data validation filters to evaluate the electricity consumption data acquired from the MDMS. CenterPoint manually reviews any instances where electricity consumption data is not validated. Estimated reads are calculated by the MDMS, CIS or manually consistent with parameters established by the Commission when issues are not resolved within a pre-determined time period. CenterPoint addresses any billing related issues as they are identified.

Electricity consumption data is transmitted from either the MDMS (interval data) or CIS (register data) to CenterPoint's Enterprise Application Interface ('EAI') after the data has passed each of the control points in the meter data management process. The EAI converts electricity consumption data (i.e., register read and interval data) into standardized data formats for transmission to the REPs (for customer billing), ERCOT (for settlement), and the Smart Meter Texas Portal.

<sup>73</sup> The data filter applied by the DCE is related to a pulse overflow issue identified by CenterPoint in March 2010 and discussed in more detail in Section X of this report.

Additional information including an assessment of the adequacy of each control point associated with the meter data management process is included in *Table 22* below.

**Table 22: CenterPoint Advanced Meter Data Management Process Control Points**

No.	Control Point Owner	Description	Assessment
1)	Itron / CenterPoint	<i>Route Acceptance Report Monitoring</i> – Advanced meters are monitored for consistent communication with the DCE on a daily basis.	Control point adequately verifies that advanced meters are consistently transmitting electricity consumption data.
2)	CenterPoint	<i>DCE and MDMS Validations</i> – Electricity consumption data transmitted from the advanced meter is analyzed for abnormal or invalid data on a daily basis.	Control point generally ensures that valid electricity consumption data is transmitted from the advanced meter.
3)	CenterPoint	<i>Advanced Meter Request Monitoring</i> – A CIS report is monitored to identify the number of successful attempts to acquire authenticated electricity consumption data from the MDMS.	Control point generally ensures that attempts to acquire electricity consumption data by the CIS are responded to by the MDMS.
4)	CenterPoint	<i>Fail-to-Bill Monitoring</i> - CIS report is monitored to identify the number of instances where the electricity consumption data is not validated by the CIS. Instances are reviewed and resolved by CenterPoint billing analyst.	Control point generally ensures that ,failure to bill' issues are resolved in a timely manner.

Our evaluation provides reasonable assurance that CenterPoint has established meter data management processes and associated controls that are sufficient to ensure that the transmission of electricity consumption data through the advanced metering system infrastructure is accurate. While no specific meter data management process and associated controls deficiencies were observed, Navigant Consulting recommends that CenterPoint develop comprehensive procedural documentation of the meter data management processes and associated controls to ensure continuity of service and reliability as staff and process requirements change over time.

c) AEP Texas' Advanced Meter Data Management Processes and Controls

We evaluated AEP Texas' advanced meter data management practices to provide reasonable assurance that the processes and associated controls utilized were sufficient to ensure that the electricity consumption data transmitted from the advanced meter through the advanced metering system and ultimately to the REPs for billing purposes is accurate. A process map that summarizes the advanced meter data management process and associated control points is attached as *Exhibit 17, 'AEP Texas Meter Data Management Process Map.'* Detailed information related to each control point in the meter data management process is included below.

- 1) *Data Transmission Report Monitoring* – AEP Texas monitors a report that identifies advanced meters that are not communicating with the network or providing data to the

Head End after installation. Advanced meters not communicating with the network for multiple days are evaluated and replaced if the meter subsequently fails to re-establish communication. AEP Texas monitors communications between the advanced meters and the Head End, and between the Head End and the MDMS, after the advanced meter is provisioned on a daily basis. AEP Texas addresses any issues that are identified.

- 2) **Command Center Validations** – The Head End system applies a number of general data validation filters (e.g., Meter Time Sync Issue, Unexpected Usage on Disconnected Meter; and Daily Usage and Demand Threshold Alerts) to identify any abnormal electricity consumption data received from the advanced meters. Any invalid electricity consumption data is not transmitted to the MDMS. AEP Texas addresses any issues that are identified through the data validation process in the Head End system.
- 3) **MDMS “Critical” Validations** – The MDMS applies a number of ‘critical’ data validation filters (e.g., Usage on an Inactive Meter; Meter Identification Invalid; Invalid Date/Time; Verify Stop Date/Time is Greater than Start Date Time; and Invalid Unit of Measure) to identify any invalid data received from the Head End system. Any invalid data is not processed by the MDMS. AEP Texas addresses any issues that are identified through the ‘critical’ data validation process in the MDMS.
- 4) **MDMS “Usage” Validations** – The MDMS also applies a number of ‘usage’ data validations filters (e.g., Spike Check, High/Low Usage Check; Sum Checks; Zero Consumption) while the electricity consumption data is processed and validated to identify any abnormal fluctuations in the data. Electricity consumption data that is not validated is analyzed, corrected and resubmitted into the system. AEP Texas addresses any issues that are identified through the ‘usage’ data validation process in the MDMS.
- 5) **SMTxP Validations** – Approximately 110 data validation filters are applied prior to submission of the electricity consumption data to the Smart Meter Texas portal to ensure that the electricity consumption data is attributed to the appropriate meter, premise, and REP. AEP Texas addresses any issues that are identified through the data validation process prior to submission to the Smart Meter Texas portal.
- 6) **MACSS Validations** – The CIS applies approximately 260 data validation filters (e.g., Read Date Not Equal To Current Date; kWh Failed Hi-Limit Check; kWh Equals Zero; Bill Data Not Available; Amount Greater Than \$300; and Average Demand Exceeds 500kW) to evaluate the electricity consumption data acquired from the MDMS during the monthly billing process. AEP Texas addresses any billing related issues as they are identified.

Electricity consumption data is converted into standardized data formats and transmitted to the REPs (for customer billing), ERCOT (for settlement), and the Smart Meter Texas Portal after the data has passed each of the control points in the meter data management process.



Additional information including an assessment of the adequacy of each control point associated with the meter data management process is included in *Table 23* below.

**Table 23: AEP Texas Advanced Meter Data Management Process Control Points**

No.	Control Point Owner	Description	Assessment
1)	AEP Texas	<b>Data Transmission Report Monitoring</b> – Advanced meters are monitored for consistent communication with the Head End on a daily basis.	Control point adequately verifies that advanced meters are consistently transmitting electricity consumption data.
2)	AEP Texas	<b>Command Center Validations</b> – Electricity consumption data transmitted from the advanced meter is analyzed for abnormal or invalid data on a daily basis.	Control point generally ensures that valid electricity consumption data is transmitted from the advanced meter.
3)	AEP Texas	<b>MDMS “Critical” Validations</b> – Data transmitted from the Head End is analyzed for abnormal or invalid data on a daily basis.	Control point generally ensures that valid data is transmitted from the Head End.
4)	AEP Texas	<b>MDMS “Usage” Validations</b> – Electricity consumption data transmitted from the Head End is analyzed for abnormal or invalid data on a daily basis.	Control point generally ensures that valid electricity consumption data is transmitted from the Head End.
5)	AEP Texas	<b>SMTxP Validations</b> – Electricity consumption data transmitted from the MDMS is validated on a daily basis.	Control point generally ensures that electricity consumption data for each premise is accurately transmitted to the Smart Meter Texas portal.
6)	AEP Texas	<b>MACSS Validations</b> – Electricity consumption data transmitted from the MDMS is validated for customer billing purposes.	Control Point generally ensures that valid electricity consumption data is utilized for billing purposes.

Our evaluation provides reasonable assurance AEP Texas has established meter data management processes and associated controls that ensure the transmission of electricity consumption data through the advanced metering system infrastructure is accurate.

### 3. Meter-to-Bill Data Analysis

Navigant Consulting evaluated the effectiveness of the communication of the register read and interval data from the advanced meters through the advanced metering system to provide reasonable assurance that the register read and interval data was transmitted correctly. The evaluation included identifying and obtaining register read and interval data from the meter and at various points in the advanced metering system including the head end system, advanced meter data management system, and the customer information system (i.e., billing system).

a) Summary of Register Read and Interval Data Acquired and Analyzed

The register read and interval data resident in the advanced meters and the advanced metering system was acquired, processed, validated, and loaded into a SQL database system for the Meter-to-Bill Analysis. The register read and interval data obtained from each TDSP are summarized below.<sup>74</sup>

**Table 24** summarizes the register read and interval data obtained from the advanced meters and the advanced metering systems for each TDSP.

Summary of Register Read and Interval Data						
System	Oncor		CenterPoint		AEP Texas	
	Register	Interval	Register	Interval	Register	Interval
<i>Meter Data</i>						
ESI IDs / Premises	263	263	159	159	32	32
# of Reads	29,320	2,785,475	27,519	2,631,359	128	12,288
<i>Head End</i>						
ESI IDs / Premises	1,299	1,299	N/A	N/A	96	96
# of Reads	235,525	23,690,070	N/A	N/A	250	24,000
<i>MDM (AODS)</i>						
ESI IDs / Premises	1,300	1,300	1,084	1,084	96	96
# of Reads	241,187	23,109,006	174,188	16,803,807	337	32,352
<i>CIS (LCIS)</i>						
ESI IDs / Premises	1,300	N/A	1,084	N/A	96	96
# of Reads	8,301	N/A	5,468	N/A	339	32,544

(i) *Oncor Register Read and Interval Data*

*Advanced Meter Data* Obtained individual load profile reports for 263 advanced meters containing over 2.7 million records of 15-minute interval data in pulse format for the January 2009 – May 2010 time period. Over 29,000 daily register reads were calculated by converting 15-minute interval pulse data to kWh and determining a cumulative to date register read value by day.<sup>75</sup>

*Head End Data* Received daily register reads in kWh format and interval data in pulse format for 1,299 advanced meters directly from the Head End as well as Head End data stored in the Interim Operational Data Store (, IODS') for the October 2009 – May 2010 time period. Data from the Head End and the IODS were combined resulting in 235,525 daily register read records.<sup>76,77</sup>

<sup>74</sup> The differences in the number of records between the various systems is a result of availability of certain data stored in the systems, as well as timing differences in when certain information was downloaded from the respective systems. The data contained in the CIS (LCIS) is on a monthly basis.

<sup>75</sup> Interval data was utilized to calculate a daily register read as the actual daily register read information stored in the advanced meters was available only for a limited time period. In addition, interval data for certain advanced meters did not contain all interval data since installation due to certain data storage limitations, as well as the result of certain firmware upgrades and / or system patches delivered to the meters through the advanced metering system. As a result, the initial calculated register read for each meter was estimated from information contained in the Head End register read data.

<sup>76</sup> The Head End system stores register read and interval data for the most recent three (3) month period. Additional Head End data was obtained from the IODS which stores historical Head End data.

<sup>77</sup> Head End data for one (1) of the 1,300 advanced meters was not provided.

<i>AODS / MDMS Data</i>	Received <i>daily</i> register reads and interval data in kWh format from the Advanced Meter Operational Data Store (, AODS'), which stores information from the MDMS, for the October 2009 – May 2010 time period. <sup>78</sup> We received approximately 241,187 <i>daily</i> register read records for 1,300 advanced meters from the AODS.
<i>LCIS Data</i>	Received <i>monthly</i> register read data in kWh format for customer premises with advanced meters from the Legacy Customer Information System (, LCIS') for the August 2005 – May 2010 time period. Identified approximately 8,300 <i>monthly</i> register reads for 1,300 advanced meters during the October 2009 – May 2010 time period.
<i>(ii) CenterPoint Register Read and Interval Data</i>	
<i>Advanced Meter Data</i>	Obtained individual load profile reports for 159 advanced meters containing over 2.6 million records of <i>15-minute</i> interval data in kWh format for the May 2009 – May 2010 time period. Over 27,000 <i>daily</i> register reads were calculated by converting <i>15-minute</i> interval data to a cumulative-to-date register read value by day. <sup>79</sup>
<i>MDMS Data</i>	Received <i>daily</i> register reads in kWh format and interval data in kWh format from the MDMS for the October 2009 – April 2010 time period. We received approximately 174,188 <i>daily</i> register read records for 1,084 advanced meters from the MDMS.
<i>CIS Data</i>	Received <i>monthly</i> register read data in kWh format for customer premises with advanced meters from the CIS for the June 2006 – March 2010 time period. Identified approximately 5,400 <i>monthly</i> register reads for the 1,084 advanced meters utilized in the Meter-to-Bill Analysis during the October 2009 – March 2010 time period.
<i>MRI / MRE Data</i>	Received approximately 5,500 <i>monthly</i> register read records in kWh format for the October 2009 – April 2010 time period. Identified approximately 5,000 applicable register read records for 1,084 advanced meters.

<sup>78</sup> Oncor's MDMS does not store historical register read and interval data. However, the AODS stores the daily register read and interval data after it has been validated and processed by the MDMS.

<sup>79</sup> Interval data was utilized to calculate a daily register read as the actual daily register read information stored in the meter was only available for a short time period. In addition, interval data for 80 meters did not contain all interval data since the installation date due to data storage limitations as well as the result of firmware upgrades and / or system patches delivered in March 2010 to the meters through the advanced metering system. As a result, the initial calculated register read for each meter was estimated from information contained in the MDMS register read data.

<i>Mkt Trans Data</i>	Received approximately 11,000 <i>monthly</i> electric usage records in kWh format for the October 2009 – April 2010 time period. Identified approximately 10,794 applicable register read records for 1,084 advanced meters.
	(iii) <i>AEP Texas Register Read and Interval Data</i>
<i>Advanced Meter Data</i>	Obtained individual load profile reports for 32 advanced meters containing over 607,000 records of <i>15-minute</i> interval data in pulse format for the March 2010 – May 2010 time period. Also obtained meter profile reports for the 32 advanced meters that contain the <i>daily</i> register reads for the most recent five (5) days of operation. <sup>80</sup>
<i>Head End Data</i>	Received <i>daily</i> register read and interval data in kWh format from the Command Center, which serves as the AEP Texas Head End system for the May 23 – May 25, 2010 time period. Data from the Command Center resulted in approximately 250 <i>daily</i> register read records for 96 advanced meters. <sup>81</sup>
<i>MDMS Data</i>	Received <i>daily</i> register read and interval data in kWh format from the MDMS for the May 22 – May 25, 2010 time period. Data from the MDMS resulted in approximately 337 <i>daily</i> register read records for 96 advanced meters.
<i>CIS / MACSS Data</i>	Received <i>daily</i> register read data in kWh format from the MACSS system, which serves as the AEP Texas customer information system, for the May 22 – May 25, 2010 time period. Data from the MACSS resulted in approximately 339 <i>daily</i> register read records for 96 advanced meters.
<i>Smart Meter Texas Data</i>	Received <i>daily</i> register read data in kWh format from the Smart Meter Texas file (, SMTxP ') which serves as the conduit for information to be sent to the Smart Meter Texas Portal for the May 23 – May 25, 2010 time period. Data from the SMTxP resulted in approximately 285 <i>daily</i> register read records for 96 advanced meters. <sup>82</sup>

b) Evaluation of Advanced Metering System Communication Effectiveness

The effectiveness of the communication between the advanced meters and various systems within the advanced metering system was evaluated during the Meter-to-Bill Analysis. We analyzed the register reads identified in the MDMS on a daily basis and the register reads in the CIS on a

<sup>80</sup> Actual daily register read information was utilized in the Meter-to-Bill Analysis as it was available in the meter profile reports due to the proximity of the data download date to the date of the register read data available in the advanced metering system.

<sup>81</sup> Head End data was not received for operational day May 23<sup>rd</sup> for AEP Texas.

<sup>82</sup> Smart Meter Texas Data was not received for operational day May 23<sup>rd</sup> for AEP Texas.

monthly basis to identify the number of automated register reads the system recorded relative to the number of estimated or manual reads that were recorded for provisioned advanced meters.

As described, a successful automated register read resident in the MDMS or CIS would indicate that the advanced meter and advanced metering system were communicating and that the information communicated by the advanced meter to the Head End, which was subsequently communicated to the MDMS, was validated and accepted. An estimated register read or, in certain situations, a manual register read recorded in the MDMS or CIS may indicate the communication between the advanced meter and the advanced metering system was not operating as intended.<sup>83</sup>

An estimated daily register read in the MDMS would indicate that on a specific day the advanced meter did not communicate and/or deliver validated information to the MDMS. However, an estimated read in the MDMS may not impact customer billing as the customer billing is based on the register reads contained in the CIS. The CIS collects a monthly register read from the MDMS on a pre-determined day during each billing cycle. An estimated read in the CIS would impact a customer's bill as the bill would be based on the estimated read and not on an actual read from the advanced meter. Estimated reads in the CIS occur less than estimated reads in the MDMS as the CIS has up to a three (3) day period to identify an automated register read in the MDMS to utilize for billing purposes.

The number of automated register reads in the MDMS and CIS relative to the number of estimated or manual register reads for provisioned meters was high for each of the TDSPs.<sup>84,85</sup>

*Table 25* summarizes the number of automated *daily* register reads in the MDMS as compared to number of estimated or manual register reads for each TDSP.

Summary of Advanced Metering System Communication - MDMS						
Read Type	Oncor		CenterPoint		AEP Texas	
	#	% of Total	#	% of Total	#	% of Total
Automated	235,697	97.7%	172,401	99.0%	337	100.0%
Manual	N/A	0.0%	182	0.1%	-	0.0%
Estimated	5,490	2.3%	1,605	0.9%	N/A	0.0%
<b>Total</b>	<b>241,187</b>		<b>174,188</b>		<b>337</b>	

***Over 97% of daily register reads in the MDMS were automated register reads for Oncor and over 99% for CenterPoint.***

<sup>83</sup> Manual register reads for advanced meters that are not fully provisioned would not necessarily be indicative of a potential communication issue as manual register reads are utilized for billing purposes prior to provisioning of advanced meters. In addition, AEP Texas' MDMS does not estimate register reads. AEP Texas's CIS estimates register reads as needed.

<sup>84</sup> We received register read data for a four (4) day period which represents data during the first week of the advanced metering system operations for AEP Texas. We did not receive register read data for all 96 meters on each day. However, we did receive at least one (1) day of register read data for each meter during the four (4) day period. All of the register reads that we received were automated reads.

<sup>85</sup> Approximately 0.73% of all CenterPoint advanced meters required an estimated read during the January – May 2010 time period. 1.09% of all electromechanical meters required an estimated read during the same time period.

*Table 26* summarizes the number of automated monthly register reads in the CIS as compared to number of estimated or manual register reads.

Summary of Advanced Metering System Communication - CIS						
Read Type	Oncor		CenterPoint		AEP Texas	
	#	% of Total	#	% of Total	#	% of Total
Automated	8,019	96.9%	4,771	97.3%	339	100.0%
Manual	192	2.3%	107	2.2%	-	0.0%
Estimated	65	0.8%	27	0.6%	-	0.0%
<b>Total</b>	<b>8,276</b>		<b>4,905</b>		<b>339</b>	

*97% of monthly register reads in the CIS were automated register reads. Less than 1% of monthly register reads were estimated reads for each of the TDSPs.*

c) Verification of Register Reads through Advanced Metering System

The Meter-to-Bill Analysis also included the verification of register reads that were communicated from the advanced meter through the advanced metering system for each of the TDSPs.<sup>86</sup> Specifically, we traced the daily and monthly register reads from 1) the advanced meters to the Head End system, 2) from the Head End system to the MDMS, and 3) from the MDMS to the CIS to provide reasonable assurance that the daily and monthly register read information was communicated accurately.<sup>87</sup> Any unexplained variances in the automated daily or monthly register reads could indicate a potential issue related to the reliability of the communication process.

(i) Verification of Oncor Register Reads

We traced the automated daily and monthly register reads from Oncor’s advanced meters to the Head End system, from the Head End system to the AODS and from the AODS to the LCIS. Specifically, we compared the register read data contained in each system on a certain day and verified that the register reads were the same. The majority of the daily and monthly register reads were traced through the advanced metering system and verified without a variance (i.e., a read in the Head End matched the same read in the AODS). However, there were a limited number of daily and monthly register reads traced through the advanced metering system where inconsistencies were initially noted. All but one (1) of these register reads were subsequently verified through other available register read data contained in the advanced metering system and through additional information provided by Oncor.<sup>88,89,90</sup> The one (1) unverified automated register

<sup>86</sup> Estimated and manual register reads were not traced through the advanced metering system as these reads would not match the data communicated from the meter through the advanced metering system.

<sup>87</sup> Daily register read and interval data are stored differently in the various systems within each TDSP’s advanced metering system. The daily register read or interval data may be stored in one data system on the actual day of the register read or it could be stored on the day after the day of the register read. These timing differences are caused by the size and complexity of the systems, as well as the amount of data that is processed and analyzed on a daily basis.

<sup>88</sup> The register reads identified with an inconsistency primarily relate to register reads in which the actual data contained in the specific advanced metering system (e.g., AODS) was inadvertently not provided by Oncor during the course of the investigation. These register reads were verified by either comparing the register read on the day before and the day after or by comparing the register read in question to

read occurred on one (1) day. The automated register read for the meter in question was verified on both the day before and after the day in question. Oncor is continuing to evaluate this inconsistency.

Table 27 summarizes the number of automated daily and monthly register reads verified in the Oncor advanced metering system.

Summary of Oncor Automated Reads Verification			
	Meter to Head End (Daily Reads)	Head End to AODS (Daily Reads)	AODS to LCIS (Monthly Reads)
Automated Reads	25,879	220,420	8,019
Verified Automated Reads	25,878	220,420	8,019
Unverified Automated Reads	1	-	-

*All but one (1) of the automated daily and monthly register reads in the Oncor advanced metering system were verified as accurate register reads.*

(ii) *Verification of CenterPoint Register Reads*

We traced the automated daily and monthly register reads from CenterPoint’s advanced meters through CenterPoint’s advanced metering system. The majority of the daily and monthly register reads were traced through the advanced metering system and verified without a variance. However, there were a limited number of daily and monthly register reads traced through the advanced metering system where inconsistencies were initially noted. All of these register reads were subsequently verified through other available register read data contained in the advanced metering system and through additional information provided by CenterPoint.<sup>91,92,93,94</sup>

additional data in other advanced metering systems (e.g., comparing CIS register read to Head End register read data).

<sup>89</sup> Verified Automated Reads without a variance were identified as any daily or monthly register reads that had a variance of less than 1.5 kWh for the Head End to MDMS and MDMS to CIS comparisons. Verified Automated Reads without a variance were identified as any daily register reads that had a variance of less than 10 kWh for the Meter to Head End comparison as the conversion calculation from pulse data to kWh could affect the accuracy of the calculated daily register read.

<sup>90</sup> All 235,697 of the automated register reads contained in the MDMS were unable to be traced as register read data from the Head End system was not provided for the same time period.

<sup>91</sup> The register reads that were identified with an inconsistency primarily relate to register reads in which the actual data contained in the specific advanced metering system (e.g., MDMS) was inadvertently not provided by CenterPoint during the course of the investigation. These register reads were verified by either comparing the register read on the day before and the day after or by comparing the register read in question to additional data in other advanced metering systems (e.g., comparing CIS register read to meter register read data).

<sup>92</sup> We evaluated the register reads contained in the ,mkt transaction file, which contains the register reads that are provided to the market for settlement purposes, and the ,MRI/MRE data file, which contains the register reads that are communicated from the MDMS to the CIS. All register reads in the ,mkt transaction file and the ,MRI/MRE data file were verified.

<sup>93</sup> Verified Automated Reads without a variance were identified as any daily or monthly register reads that had a variance of less than 1.5 kWh for the Meter to MDMS and MDMS to CIS comparisons.

<sup>94</sup> All 172,401 of the automated register reads contained in the MDMS were unable to be traced as register read data from the advanced meters was not provided for the same number of advanced meters, as well

*Table 28* summarizes the number of automated daily and monthly register reads that were verified for the CenterPoint advanced metering system.

Summary of CenterPoint Automated Reads Verification		
	Meter to MDMS (Daily Reads)	MDMS to CIS (Monthly Reads)
Automated Reads	13,377	4,771
Verified Automated Reads	13,377	4,771
Unverified Automated Reads	-	-

*All of the automated daily and monthly register reads in the CenterPoint advanced metering system were verified as accurate register reads.*

(iii) *Verification of AEP Texas Register Reads*

We traced the automated daily register reads from AEP Texas’ advanced meters to the Head End system, from the command center system to the MDMS and from the MDMS to the MACSS to verify that the daily register read information was communicated accurately from the advanced meters through AEP Texas’ advanced metering system. Specifically, we compared the register read data contained in each system on a certain day and verified that the register reads were the same. As described, the AEP Texas daily register read data analyzed is for a four (4) day period and represents data during the first week of the advanced metering system operations, as this was all that was available. This daily register read information is currently not utilized for billing purposes. However, all of the daily register reads provided were traced through the advanced metering system and verified without a variance.<sup>95</sup>

*Table 29* summarizes the number of automated daily register reads that were verified for the AEP Texas advanced metering system.

Summary of AEP Texas Automated Reads Verification			
	Meter to Head End (Daily Reads)	Head End to MDMS (Daily Reads)	MDMS to MACSS (Daily Reads)
Automated Reads	250	337	339
Verified Automated Reads	250	337	339
Unverified Automated Reads	-	-	-

*All of the automated daily register reads in the AEP Texas advanced metering system were verified as accurate register reads.*

as the same time period as the register reads contained in the MDMS. We obtained register read data for 1,084 advanced meters from the MDMS and interval data, which was used to calculate daily register reads, directly from 159 advanced meters. In addition, interval data for 80 meters did not contain all interval data since the installation date due to data storage limitations, firmware upgrades and/or system patches delivered in March 2010.

<sup>95</sup> We evaluated the register reads contained in the SMTxP file that contains register reads communicated from the MDMS to the Smart Meter Texas Portal. All register reads in the SMTxP file were verified.



4. Meter to Back-End System Verification Analysis (On-Demand Read)

During the Meter Exchange process conducted in the Oncor, CenterPoint and AEP Texas service territories and the Field Testing process conducted in the Oncor service territory, Navigant Consulting personnel completed a Meter to Back-End System Verification Analysis (On-Demand Read) to test the ability of the TDSPs to accurately read advanced meters remotely for approximately 657 advanced meters.

The On-Demand Reads were performed to ensure that the advanced metering system could communicate remotely ,on-demand' with the advanced meters in the field. An On-Demand Read was considered successful if the TDSP analyst was able to provide a remote advanced meter read that matched the manual read observed in the field.<sup>96</sup> The remote advanced meter read matched the manual read for all On-Demand Reads where the TDSP analyst was able to remotely communicate with the advanced meter through the advanced metering system. An On-Demand Read was considered unsuccessful if the TDSP analyst could not remotely communicate with the advanced meter through the advanced meter system.

*Table 30* summarizes the results of the On-Demand Read analysis for each of the TDSPs.

TDSP	Successful		Unsuccessful		Total Attempted
	Count	% of Total Attempted	Count	% of Total Attempted	
<b>Oncor</b>					
Meter Exchange	229	84.19%	43	15.81%	272
Field Testing	162	83.51%	32	16.49%	194
Oncor Total	391		75		466
<b>CenterPoint - Meter Exchange</b>	152	95.60%	7	4.40%	159
<b>AEP Texas - Meter Exchange</b>	32	100.00%	-	-	32
<b>Total</b>	575	87.52%	82	12.48%	657

*Approximately 85% of the On-Demand Reads attempted in the Oncor service territory were successful. Over 95% of the On-Demand Reads attempted in the CenterPoint service territory and 100% of the On-Demand Reads attempted in the AEP Texas service territory were successful.*

While we would not expect all advanced meters to remotely communicate ,on-demand' due to the nature of the communication network, we nonetheless evaluated the cause of each unsuccessful On-Demand Read. The majority (over 90%) of the unsuccessful On-Demand Reads were the result of a ,timed-out read' by the TDSP analyst. Specifically, the TDSP analyst was unable to remotely communicate with the advanced meter installed at the premise at the time of the On-Demand Read

<sup>96</sup> Minor discrepancies were noted between the remote On-Demand read obtained from the TDSP analyst and the manual read recorded in the field in certain instances as the remote On-Demand Reads were obtained before Navigant Consulting personnel observed the meters and acquired the manual reads. These minor discrepancies were likely due to the amount of electricity used at the premise between the time the remote On-Demand Read and manual reads were obtained (approximately 15-minutes in most cases) and typically amounted to less than two (2) kWh.

attempt. An unsuccessful On-Demand Read would not necessarily indicate that a meter was operating incorrectly (all advanced meters with unsuccessful On-Demand Reads tested accurately). Due to communication network limitations, as well as upgrades and other initiatives that require a significant amount of data bandwidth, there are periods of time in which certain groups or individual advanced meters may not be able to communicate with the advanced metering system ,on-demand.' However, these advanced meters may have been communicating with the advanced metering system during the regularly scheduled communication intervals. As of the time of this Report, the TDSPs are continuing to evaluate and investigate why On-Demand Reads for certain advanced meters were unsuccessful.

The remaining unsuccessful On-Demand Reads, including instances in which a TDSP analyst could not be contacted, instances in which an advanced meter was not established on a communicating route (i.e., not on collector), and instances in which the meter was not provisioned on the advanced metering system (i.e., meter in discover status) were not the result of any communication issues in the advanced metering system as these unsuccessful On-Demand Reads would be expected based on the status of the advanced meter in the advanced metering system.

*Table 31* summarizes the explanations related to the unsuccessful On-Demand Reads.

Summary of Unsuccessful On-Demand Read / Analysis				
Explanation	Oncor		CenterPoint	
	Count	% of Unsuccessful Reads	Count	% of Unsuccessful Reads
Attempt Timed Out	68	90.67%	7	100.00%
Could not Contact TDSP Analyst	3	4.00%		
Meter in "Discover" status	2	2.67%		
"Not on Collector"	2	2.67%		
Total	75	100.00%	7	100.00%

**X. Review of Identified Issues and Corrective Actions**

**A. Background**

Throughout the course of Navigant Consulting’s evaluation of advanced metering system deployment in Texas, we have reviewed, analyzed and observed many aspects of Oncor, CenterPoint and AEP Texas’ operations from the testing and deployment of advanced meters to the use of customer electric usage information that is measured, recorded, stored and communicated from advanced meters through the respective TDSP’s customer information systems. Our efforts focused on the most critical aspects of advanced meter deployment including the accuracy of advanced meters, as well as questions and concerns raised by customers regarding higher electric bills after advanced meters were deployed.

**B. Scope of Work**

Navigant Consulting’s efforts were targeted at identifying and evaluating potential issues to provide reasonable assurance that the advanced meters being deployed are accurate and that Oncor, CenterPoint and AEP Texas have, as well as continue to develop, the necessary processes and controls to ensure that the advanced meters and metering systems provide a reasonable basis for measuring, recording, storing and communicating customer electric usage for use in the customer billing process.

While our evaluation and investigation has been comprehensive in the areas reviewed, it was not exhaustive across all aspects of the respective TDSPs’ advanced metering systems. Given the complexity of the advanced meters and metering systems involved, as well as the fact that the embedded technology and surrounding processes and controls continue to evolve to provide better customer service and more efficient operations for the utilities, evaluating all aspects of the relevant systems and controls would have required additional time and expense to the TDSPs beyond that outlined in Navigant Consulting’s scope of work.

**C. Work Performed**

In addition to evaluating various issues identified during the course of our evaluation, Navigant Consulting also evaluated the respective advanced meters and metering systems relative to other issues that had previously been identified and reported to the Commission by the respective TDSPs. Each of these issues is addressed below.

Where issues or questions have arisen, Navigant Consulting engaged in detailed discussions with relevant individuals at each TDSP and, as applicable, associated companies (e.g., meter manufacturers, independent testing operations, meter installation subcontractors, software developers, etc.) to ensure that each issue was investigated to the fullest extent possible. At the conclusion of our investigation, our observations and findings were discussed with each TDSP to ensure that our assessments were factually correct and that the TDSP was aware of our conclusions.

Each identified issue was evaluated relative to: 1) how the issue was identified; 2) the number of advanced meters and customers potentially affected by the issue; 3) the potential impact, if any, to the respective customers; 4) the number of erroneous customer bills resulting from the issue, if any; and 5) how the issue was remediated by the TDSP including steps taken to prevent similar occurrences in the form of enhanced processes, policies or controls, or potential system, advanced meter hardware or firmware changes.

#### D. Observations and Findings

During our investigation and evaluation we have made various observations regarding the accuracy of the advanced meters being deployed, as well as the integrity and reliability of the processes and controls surrounding advanced meter deployment and the overall advanced metering systems of Oncor, CenterPoint and AEP Texas. However, as with the development and deployment of any large complex system, especially where new technology is involved, we did not expect to encounter systems and processes that were free of any need for improvement. Nor did we expect that each advanced meter and process would be 100% accurate and working efficiently and effectively. As with any system that is designed, developed and controlled by humans, there is the possibility of error, oversight and inconsistency that can always be improved.

While we believe that our efforts have identified certain significant issues that have impacted the effective and efficient operations of a limited number of advanced meters, there may be other issues we did not identify or areas outside the scope of our work where advanced meters and advanced metering systems are not operating at optimal levels. As is expected with any deployment of new systems and technology, Oncor, CenterPoint and AEP Texas have needed to investigate and remediate various issues over the course of their advanced meter deployment and advanced metering system implementation – and such efforts will undoubtedly continue in the future.

It is important to note that the evaluation of some of the issues described below is continuing and the potential impact to customers' affected by these issues, as well as remediation if necessary, is continuing to be evaluated. Of the issues identified during our investigation, the respective TDSPs have assembled teams of appropriate individuals to quickly and efficiently address the issues. The issues identified with respect to each TDSP are described in more detail below.

##### 1. Oncor Related Issues

###### Investigation into the Two (2) Identified Meters that Failed Accuracy Testing

Additional investigation and analysis was performed on two (2) Oncor advanced meters found to be out of calibration during our advanced meter accuracy testing. Navigant Consulting, Luthan, Oncor and Landis+Gyr, the manufacturer of the two (2) meters in question, conducted a joint investigation into the potential root causes of the observed failures. In addition to investigating the potential cause of the advanced meter failures, the respective customers' historical billing information were analyzed to determine what impact the advanced meters may have had on the amount of electricity each customer was billed, and whether billing adjustments are warranted. Further, Navigant Consulting and Oncor (with the support of Landis+Gyr) made efforts to identify whether the advanced meters could have been identified sooner, or are indicative of problems that may be more widespread than the two (2) meters in question.

During the course of the investigation, the two (2) advanced meters were personally delivered by Luthan to Landis+Gyr for further technical evaluation. Significant care was taken to preserve the meters in their original state so as not to interfere with efforts to evaluate the potential root cause of the meter failures, or analysis of the potential impact to the respective customers. As such, so-called 'non-destructive testing' was performed on each of the meters in question.

Navigant Consulting, Oncor, Luthan and Landis+Gyr, as well as a representative from the Commission, witnessed the initial technical evaluation. The meters were retested for accuracy by Landis+Gyr, who confirmed the test results by Luthan. The data stored on each of the meters, including the meter event history and diagnostic logs, as well as the periodic electric usage interval data (i.e., usage per every 15 minutes) was downloaded for further review and analysis. Historical electric usage and billing records were also analyzed, as well as any prior complaints or concerns related to the meters, including whether the meters had a history of effective communication with Oncor's advanced metering systems. The findings to date are described below.

a) 'Rev D' Modular Advanced Meter Issue – June 2010

- 1) ***Discovery / description of the issue:*** One (1) advanced meter ('Meter #258') tested at 139% during the independent meter accuracy testing performed by Navigant Consulting and Luthan (i.e., 39% above its expected level of performance). The 139% accuracy was confirmed upon subsequent testing by Landis+Gyr. Non-destructive technical evaluation methods were utilized by Landis+Gyr to disassemble the meter so that its individual components could be inspected and analyzed. An internal manually-soldered (i.e., hand-soldered) joint on one (1) of the components was observed to be potentially faulty. Upon completion of the inspection, the meter was reassembled and retested. However, upon retest the meter tested at 99.99% accuracy suggesting that the problem may have been intermittent (i.e., the meter may not have been inaccurate all of the time).

Upon significant additional testing, analysis and evaluation, Landis+Gyr confirmed the identified reason for the meter failure resulted from a workmanship quality issue (i.e., human error) in the hand soldering of a specific component to the integrated circuit board of the advanced meter. In essence, the failed solder joint resulted in a faulty (potentially intermittent) connection that impacted the operation of the internal clock of the advanced meter, which allowed the meter to run faster than expected.

- 2) ***Number of advanced meters / customers potentially affected:*** Meter #258 was determined to be a 'Rev D' modular advanced meter, which is one (1) of three (3) basic advanced meter types currently used by Oncor. The Rev D advanced meter was the first advanced meter put into production by Landis+Gyr in its current Focus family of advanced meters, and the first advanced meter deployed by Oncor. Oncor originally purchased and deployed approximately 128,000 Rev D advanced meters in late 2008 and early 2009. The Rev D advanced meter is the only advanced meter in use by Oncor that has components that are hand-soldered to the integrated circuit board.

The other advanced meters in service consist primarily of , Rev G' modular advanced meters and , Integrated Circuit' meters, which is the current version being deployed by Oncor. The Rev G advanced meter has a machine mounted component, as opposed to the hand-soldered component in the Rev D. The Integrated Circuit advanced meters has the components in question integrated into the meter's circuit board. The approximate number of the primary advanced meter types in service is summarized in *Table 32* below:

Advanced Meter Type	# of Meters in Service	% of Meters in Service
Rev D Modular	121,770	11%
Rev G Modular	205,882	19%
Integrated Circuit	761,290	70%
<b>Total</b>	<b>1,088,942</b>	<b>100%</b>

Upon discovery that the issue pertained to a hand-soldered joint, Navigant Consulting, Oncor and Landis+Gyr undertook to evaluate the possibility that other Rev D meters with similar workmanship quality issues could be in service and not functioning to expected performance standards. During the course of the investigation, it was determined that Meter #258, in performing its self-diagnostic checks, had identified and recorded the period of time that it was malfunctioning. In other words, the observed event resulting in the inaccuracy of the meter in question had been flagged and communicated by the meter at numerous points in its operating history, but failed to be acknowledged as such by Oncor and Landis+Gyr.

Upon further inspection, it was confirmed by Oncor and Landis+Gyr that the advanced meter had been logging (i.e., recording and communicating) certain ,event codes' when the meter's internal clock was no longer consistent with the two (2) independent system checks used to maintain meter clock accuracy. After additional analyses and test simulations, Landis+Gyr concluded that one identified event code (i.e., ,2118 event code') was a reliable determinate of other advanced meters with this potential issue. As such, Oncor undertook an evaluation of all advanced meters in service (over one million advanced meters) to identify other meters that, at any point in time, had recorded a similar 2118 event code.

Oncor identified approximately 439 other Rev D meters that had displayed a similar event code in the past, as well as 831 Rev G meters that are discussed further below. The majority of the Rev D meters were removed from service and subjected to accuracy testing. As of the date of this Report, Oncor has tested 95% of these meters and found 74 to be outside of the accuracy standards of +/- 2.0% set by the Commission. A small number of advanced meters also would not test. Almost all of the advanced meters that failed accuracy testing where the hand-soldered joint is in question were running faster than expected.

In addition, Navigant Consulting sampled another 250 Rev D advanced meters that had not displayed the identified event code at any time in the past to provide additional information with regard to the integrity of the hand-soldered joints in question. The sampled Rev D meters were first accuracy tested by Luthan to ensure they were operating within the range of expected performance. Each of the meters tested was found to be accurate.

100 Rev D advanced meters were then sent to Landis+Gyr to be evaluated, including disassembly and inspection with a high-resolution microscope. The inspections were conducted with Navigant Consulting, Oncor, Luthan and Commission representatives present for a majority of the work. Approximately 161 Rev D meters were evaluated (including a sample of 61 Rev D meters previously sent to Landis+Gyr by Oncor for similar evaluation). Concerns were noted with respect to at least one (1) hand-soldered joint on 17 (or ~10%) of the advanced meters inspected. An additional 60 advanced meters inspected had one (1) or more solder joints that were below the standards set for such work but were still believed to present no reliability concerns.

- 3) ***Estimate of potential impact to customers:*** While 439 Rev D advanced meters have displayed a 2118 event code, not all of the observed event codes are believed to have resulted from workmanship quality issues in the described hand-soldered joint. However, of the 74 Rev D meters that tested as inaccurate, a majority of the meters testing significantly outside of acceptable limits appear to be Rev D meters with questionable solder joints. Other 2118 event codes are believed to relate to a secondary issue, which is described further below in conjunction with Rev G modular advanced meters that also have displayed a 2118 event code. As a result, customers who had one of the 439 Rev D advanced meters identified to date that have displayed the 2118 event code, which have now been removed from service, could have received one or more electric bills from their REP that included electric usage in kilowatt hours that was not accurate. And, in many cases, the recorded electric usage is likely higher than it should have been.

It is important to note however, that the identified issue has been defined as an intermittent issue where the advanced meter could have strayed outside of its expected range of performance (thereby triggering the described event code) but then self-corrected back to within expected performance standards. As such, it is not expected that all customers were significantly impacted from the date of the first identified event code, or that all advanced meters with the 2118 event code were operating outside of expected performance standards for an extended period of time even after triggering the 2118 event code.

- 4) ***Number of erroneous bills produced:*** Historical customer billing information for the 439 customers with the Rev D meters in question is currently being evaluated relative to the identified periods where the meters appear to have ceased to operate in accordance with design specifications. At present, and out of an abundance of caution, Oncor is assuming that the electric usage and subsequent billing information for any Rev D meter that has displayed the 2118 event code in question is no longer reliable for use.

Oncor is continuing to evaluate the potential impact to customers who had the 439 Rev D advanced meters in question including evaluating the historical electric usage for customers potentially impacted by this issue, as well as utilizing its traditional methods to determine potential billing impacts to the customers affected. Oncor is expected to remediate the identified overbilling of customers in the near future.

At present, Oncor estimates that not all of the 439 customers have been impacted by a quantifiable amount. While a meter may have displayed a 2118 event code, the meter may not have operated outside of expected performance standards for any significant length of time prior to the meter self-correcting the problem. In addition, while some of the 439 advanced meters in question displayed multiple 2118 event codes over an extended period, others displayed only a single event code, which, by definition, would have limited the period the advanced meter was potentially inaccurate to less than 24 hours.

- 5) **Root cause analysis and corrective action:** As described above, the root cause of the identified meter failures was traced to a faulty hand-soldered joint of a component to the integrated circuit boards, which is exclusive to Rev D modular advanced meters. Out of approximately 121,000 Rev D meters currently in service, only 439 Rev D advanced meters have been identified with a similar issue at this time (i.e., less than one-half of one percent).

Almost all of the meters in question have been removed from service and remediation efforts are currently underway by Oncor to address impacts to customers potentially affected by these meters. In addition, Oncor has modified its current system (i.e., Command Center) reporting to identify any additional 2118 event codes on Rev D meters at the end of each day and has established a process to notify their billing system that electric usage (i.e., billing) information subsequent to the occurrence of a 2118 event code is no longer reliable. Oncor is removing the meters from service within 24 hours of notification, or as soon as practicable.

While both Oncor and Landis+Gyr are confident that any additional customer impact from the Rev D meters with similar workmanship quality issues can be effectively identified and contained with minimal customer impact, additional testing and analysis is continuing in relation to this issue, including an evaluation of overall quality concerns with regard to the hand-soldered joints on the remaining Rev D modular advanced meters in service.

b) Advanced Meter CT (Current Transformer) Issue – June 2010

- 1) **Discovery / description of the issue:** One (1) advanced meter (, Meter #053') tested at 93% (i.e., 7% below its expected level of performance) during the independent meter accuracy testing performed by Navigant Consulting and Luthan. The 93% accuracy was confirmed upon subsequent testing by Landis+Gyr. The meter was initially identified by Luthan because it originally would not test due to a loose wire inside the meter, raising a concern for possible tampering with the meter.

The meter was disassembled by Landis+Gyr using non-destructive technical evaluation methods and its individual components were inspected and analyzed. Upon completion of the inspection, the meter was reassembled and retested. The meter continued to test at 93% accuracy. During the inspection, evidence pointing to a potential problem with the Current Transformer (CT) in the meter base was observed. Upon replacement of the meter base with a different meter base, the meter tested at 99.8% accuracy, further supporting a potential problem with the CT.



Upon further analysis, Landis+Gyr confirmed that the CT on Meter #053 failed resulting in the meter running slower than expected. It was generally agreed however, given the nature of the anomaly, and the limited occurrence of similar problems with this aspect of advanced meters produced by Landis+Gyr in recent years, that the existence of similar problems with advanced meters currently deployed would likely be remote. Regardless, Oncor and Landis+Gyr initiated efforts to evaluate other advanced meters observed to be running slow for potential problems with the CT. At present, Landis+Gyr has identified 43 additional meters with a similar failed CT, with most of the meters being of the Rev D and Rev G types.

It is important to note, that most of these meters were identified because they had displayed a ,non-volatile memory' failure (,NVM event') code, which Oncor was also evaluating and which is described further below. The connection between the NVM error and the failed CT is still being investigated by Landis+Gyr.

- 2) ***Number of advanced meters / customers potentially affected:*** The occurrence of a failed CT in advanced meters deployed by Oncor appears to be limited to the 43 meters identified to date. Oncor and Landis+Gyr are continuing to evaluate other failed meters to determine whether the observed failures and identified inaccuracy in these meters could be related to a failed CT, as well as whether these meters could have been detected through existing, or enhanced, meter validation checks.
- 3) ***Estimate of potential impact to customers:*** Oncor is currently evaluating the potential impact that Meter #053, as well as the additional 43 advanced meters identified, may have had on historical customer billing. Meter #053 was operating slower than expected (at 93%), as were the other 43 meters identified, which ultimately resulted in a benefit to the customer during the periods when the meter was not operating in accordance with acceptable performance standards. Oncor is currently evaluating how long some of these advanced meters may have been operating outside of their acceptable performance standards prior to failure, but there is believed to be minimal to no customer impact as all of these meters appear to have been running slow.
- 4) ***Number of erroneous bills produced:*** As described, Oncor is in the process of evaluating what impact Meter #053, as well as the other identified meter failures, may have had on the respective customers. Oncor will not re-bill any customers who appeared to have been undercharged as a result of an advanced meter operating slower than its expected performance. To the extent any advanced meters are determined to have been operating faster than acceptable performance standards, Oncor is expected to remediate the relative impact to the customer during such periods.
- 5) ***Root cause analysis and corrective action:*** Meter failures in general are not uncommon and can occur for a variety of reasons whether the meter is an electromechanical or advanced meter. Variations in how meters are treated (i.e., the condition of meters) both before and after installation can have an impact on the operation and expected longevity of a meter. In addition, the improper installation of a meter or the condition of the meter socket, as well as numerous other factors can impact the proper operation of a meter, which can lead to slow or

rapid deterioration of the proper functioning of the meter including the potential failure of a CT as observed. Oncor and Landis+Gyr have noted evidence of potential tampering with regard to a significant number of the 43 advanced meters with a failed CT. Landis+Gyr is continuing to evaluate and investigate the potential root cause of the observed failures including investigating potential tampering with the meters in question as the potential cause of a significant number of the observed failures.

c) Rev D and Rev G Modular Advanced Meter Issue – June 2010

- 1) ***Discovery / description of the issue:*** During the investigation of the Rev D modular advanced meter issue described above, including evaluation of the identified 2118 event code as a potential determinate of the described issue, Oncor and Landis+Gyr observed another potential issue that also gave rise to a 2118 event code. In evaluating the population of advanced meters that had displayed a 2118 event code in the past, Oncor identified approximately 831 Rev G advanced meters that had also displayed 2118 event codes.

It is important to note that a 2118 event code relates primarily to an inconsistency between the meter clock and one of the two independent validation checks on the appropriate functioning of the meter clock. As such, more than one potential issue could lead to an inconsistency between the meter clock and its validation point.

Based on Landis+Gyr's evaluation to date, the issue resulting in the 2118 event codes on the Rev G modular advanced meters appears to be a secondary issue involving the same or similar components and circuits as that identified in relation to the Rev D meters, but resulting from some other root cause instead of the questionable solder joints. Landis+Gyr also believes that some of the observed 2118 event codes on the Rev D advanced meters are in fact due to this observed secondary issue, and not an indication of a faulty solder joint.

- 2) ***Number of advanced meters / customers potentially affected:*** As described above, the Rev G modular advanced meter is one (1) of three (3) basic advanced meter types currently in use by Oncor. The Rev G meter was the second advanced meter type deployed by Oncor. Oncor originally purchased approximately 246,000 Rev G advanced meters for deployment in early 2009. The Rev G advanced meter has the same circuit board as the Rev D meter, but has machine mounted components in place of the hand-soldered components.

As of the date of this Report, almost all of the 831 Rev G meters that displayed a 2118 event code in the past have been removed from service. 817 of the Rev G meters removed from service have been tested for accuracy. Eleven (11) of the 831 Rev G meters (or less than 2%) were determined to be operating outside of acceptable performance standards.

- 3) ***Estimate of potential impact to customers:*** Only a small proportion of the identified Rev G advanced meters with a 2118 event code appear to not have been accurately recording electric usage. In addition, it is important to note that the identified issue is believed to be an intermittent issue where the advanced meter could have strayed outside of its expected range of performance (thereby triggering the described event code) but then self-corrected back to

within acceptable performance standards. As such, it is not expected that all customers were significantly impacted from the date of the first identified event code, or that all Rev G advanced meters with the 2118 event code were operating outside of acceptable performance standards for an extended period of time after triggering the 2118 event code.

Seven (7) of the 11 Rev G meters operating outside of acceptable performance standards were running slower than expected. On average, the remaining 4 advanced meters that were running faster than expected were running less than 3% outside of acceptable performance standards.

- 4) ***Number of erroneous bills produced:*** Historical customer billing information for the 831 customers with the Rev G advanced meters that displayed the 2118 event code in the past is currently being evaluated relative to the identified periods where the meter ceased to operate in accordance with design specifications. At present, and out of an abundance of caution, Oncor is assuming that the electric usage and subsequent billing information for any meter that has displayed the 2118 event code in question is no longer reliable for use.

As an alternative, Oncor is applying the same remediation protocol and billing estimation routines as described above in relation to the Rev D advanced meters to evaluate each respective customer's estimated usage in the periods subsequent to when their meter exhibited the 2118 event code.

At present, Oncor does not believe that all 831 customers have been negatively impacted as a result of the observed 2118 event code. A number of the observed 2118 event codes appear to be related to other reasons for why a meter clock may have been out of sequence, including temporary time related events caused by power outages that would not have an impact on customer billing. In addition, while a meter may have displayed a 2118 event code, the meter may not have operated outside of acceptable performance standards for any significant length of time prior to the meter self-correcting the problem. Some of the advanced meters in question displayed multiple 2118 event codes over an extended period, while others displayed only a single event in one 24 hour period. Oncor and Landis+Gyr also believe that a number of the Rev D meters displaying a 2118 event code also did so as a result of this secondary issue.

Oncor is continuing to evaluate the potential impact to customers who had the 831 Rev G advanced meters in question and is expected to remediate any potential overbilling of customers within the near future.

- 5) ***Root cause analysis and corrective action:*** As described above, the root cause of this issue with the Rev D and Rev G advanced meters is still under investigation by Landis+Gyr. However, Landis+Gyr believes that the identified issue is related to a similar group of components and associated operations as the Rev D issue, but involves a more limited and discrete impact than experienced as a result of the faulty solder joint.

Out of the approximate 205,000 meters currently in service, only 831 Rev G advanced meters have been identified with a potentially similar issue at this time (i.e., less than one-half of one percent). Navigant Consulting also pulled an additional sample of 250 Rev G meters for accuracy testing by Luthan. All of the supplemental Rev G meters tested were found to be accurate.

Almost all of the Rev G meters in question have been removed from service and remediation efforts are currently underway by Oncor to address impacts to customers potentially affected by these meters. In addition, as described above, Oncor has modified its current system reporting and procedures to identify any additional 2118 event codes on both Rev D and Rev G meters at the end of each day, as well as notifying their billing system that any information subsequent to the occurrence of the 2118 event code is no longer reliable. Oncor is removing such meters from service within 24 hours of notification, or as soon as is practicable.

While both Oncor and Landis+Gyr are confident that any additional customer impact from the Rev G meters with similar issues causing the 2118 event code can be effectively identified and contained with minimal customer impact, additional testing and analysis is continuing by Oncor and Landis+Gyr in relation to this issue.

d) Non-Volatile Memory (NVM) Advanced Meter Issue – July 2010

- 1) ***Discovery / description of the issue:*** As a result of the identified Rev D and Rev G advanced meter issues described above, and the fact that the meters in question had identified the potential inconsistency through self-diagnostic checks and event driven codes, Oncor embarked on an aggressive effort to evaluate the historical event logs of all advanced meters in service for other potential issues, as well as to reevaluate their existing procedures in responding to various meter related events and errors.

During the course of their evaluation, Oncor identified another issue described as an event code related to a 'non-volatile memory' failure ('NVM event') of the advanced meters in the ability of the meter to read or write information to certain areas of its memory. At present, little is known about the potential cause or impact of the NVM event. However, as described above in relation to the description of meter failures resulting from a failed CT, Landis+Gyr currently believes there is a correlation between the two events but is continuing to investigate the potential root cause of the identified event and what impact, if any, the event could have on the accuracy of the advanced meters and their ability to accurately record electric usage.

- 2) ***Number of advanced meters / customers potentially affected:*** At present, the NVM event code has been identified by Oncor in the event logs of approximately 989 advanced meters. The NVM event code was found across all three meter types currently in use by Oncor. Almost all of these meters have been removed from service. As of the date of this Report, Oncor has tested 839 of the advanced meters that have displayed an NVM event code. In addition to the 43 advanced meters with a failed CT, which also had an NVM event code, Oncor has identified 21 additional meters to be outside of the accuracy standards set by the

Commission (64 meters total with an NVM event code). Almost all of these meters were running slower than expected.

- 3) ***Estimate of potential impact to customers:*** Oncor and Landis+Gyr are continuing to evaluate the potential root cause of the meters displaying an NVM event code and meter related failures, as well as the potential correlation with the advanced meters found to have a failed CT. It is important to note, that even if an advanced meter fails to write to memory on the first try, the advanced meter will make multiple attempts. The meter will record each failure as a separate NVM event code. However, if it is subsequently successful, it will still have recorded the NVM event code. As such, a significant number of the observed NVM event codes could relate to advanced meters that ultimately do not have an issue.

In addition, almost all of the advanced meters displaying an NVM event code that were found to be operating outside of expected performance standards were operating slower than expected. As such, it appears that customers who had these advanced meters would not have been negatively impacted.

- 4) ***Number of erroneous bills produced:*** Oncor will not re-bill any customers who appeared to have been undercharged as a result of an advanced meter operating slower than its expected performance. To the extent any of the 989 advanced meters that have displayed an NVM event code are determined to have been operating faster than acceptable performance, Oncor is expected to remediate the relative impact to the customer during such periods.
- 5) ***Root cause analysis and corrective action:*** Oncor and Landis+Gyr are continuing to evaluate and investigate the potential root cause of the observed NVM event codes and the potential correlated failures with the observed failed CT.

Issues Reported by Oncor to the Commission

e) Zero Billed Customer Issue – March 2010

- 1) ***Discovery / description of the issue:*** Oncor discovered an issue, which was reported to the Commission in Oncor's March 22, 2010 Market Notice report, related to the completion of advanced meter change-out service orders. The issue, which began in the spring of 2009, occurred when the meter change-out service order associated with an advanced meter installation was not completed in the advanced metering system prior to the subsequent bill cycle. As a result, meters reads communicated by the advanced meters were not recorded in the advanced metering system typically resulting in ,zero' bills for the customers affected.
- 2) ***Number of advanced meters / customers potentially affected:*** Oncor identified and reported up to approximately 2,000 customers that may have been impacted by this issue.
- 3) ***Estimate of potential impact to customers:*** Oncor reviewed the bills for all customers who had an advanced meter with this issue. The review determined that impact to a customer's billing was minimal. Since the electric usage (i.e., meter reads) communicated by the newly installed advanced meters was not being accepted by the advanced metering system (i.e.,

MDMS) due to the incomplete service orders, customer bills were either 1) delayed until the advanced meter was communicating with the advanced metering system; 2) sent to the customer with ,zero' electric usage (i.e., no charges for electricity consumption); or 3) estimated consistent with Commission rules. This issue was not related to advanced meter accuracy and was the result of human error in the advanced meter installation process.

- 4) **Number of erroneous bills produced:** Oncor reported that bills for approximately 2,000 customers could have been impacted by this issue for a period no longer than nine (9) months. However, most of the customer bills were impacted for fewer than nine (9) months. Oncor re-billed customers as necessary.
- 5) **Root cause analysis and corrective action:** Oncor determined that the issue was related to incomplete meter change-out service orders when it was identified in March 2010. Customers impacted were re-billed for their actual consumption during the periods in question using prorated reads. In addition, customer bills for certain REP change and customer move in / move out transactions were delayed or required estimated bills.

Oncor addressed this issue by instituting a new monitoring control process within its Market Operations group to ensure completion of meter change-out service requests and expedited completion of incomplete documentation by Oncor's Measurement Services group to prevent a recurrence of this issue. These additional validations were instituted in March 2010 and are detailed in *Table 33* below.

No.	Validation	Action
1)	Hold Queue Report	Identify premise visits where the field action has not been updated in LCIS.
2)	FME Error Report	Monitor report to identify and avoid potential FME errors.
3)	Billing Adjustment (,BA') Report	Monitor to identify delays in service order completion.

f) 1,827 High Billed Customer Issue – April 2010

- 1) **Discovery / description of the issue:** Oncor discovered an issue, which was reported to the Commission during the March 2010 Open Meeting, related to higher than expected customer bills in the month(s) following installation of new advanced meters. The issue was identified through a number of REP and customer inquiries regarding the higher than expected bills. In December 2009, Oncor's Customer Service department identified that, in a number of cases, the two (2) separate out-read records created during replacement of an electromechanical meter with an advanced meter did not match. The first out-read is entered into a handheld device (,In-Service') by Oncor service technicians who replace electromechanical meters with advanced meters. The second out-read is entered into a device (,Omnibound') by personnel in the meter deployment staging area where electromechanical meters are returned.
- 2) **Number of advanced meters / customers potentially affected:** Oncor identified and reported a total of 1,827 customers impacted by this issue.

- 3) **Estimate of potential impact to customers:** Oncor reviewed electromechanical meter out-reads for all premises where advanced meters had been deployed. Where the out-reads did not match, Oncor determined that the resulting impact on customer billing varied from \$12 to \$660. This issue was not related to meter accuracy. The issue was the result of human error, compounded by the lack of a data cross check process and failure to maintain photographic records of removed electromechanical meter out reads.
- 4) **Number of erroneous bills produced:** Oncor reported that 1,827 customers were impacted by this issue, resulting in 1,794 erroneous bills. Oncor re-billed customers as necessary.
- 5) **Root cause analysis and corrective action:** Oncor determined that the issue was related to a deficiency in the meter change out process specifically in the out-reads for electromechanical meter removed from service. Oncor enhanced the meter change out process in March 2010 by incorporating a number of additional validation checks to ensure that the out-reads for the replaced electromechanical meters were recorded accurately. The additional validations (',Don Report' and the ',Post Audit Validation Report') as well as the original validations in the meter change out process are detailed in *Table 34* below.

No.	Validation	Action
1)	Meter out-read validation	Program instantaneously compares the reading entered by the Meter Handler to the reading entered by the Meter Installer and provides an audible alarm if the readings do not match. If the readings do not match, the Meter Handler ensures that the correct reading is entered.
2)	Meter faceplate photograph	A digital photo of the meter (including meter number and dial positions) is taken of the recorded final out-read.
3)	',Don Report'	The ',Don Report' identifies any out-read errors during advanced meter deployment. Oncor billing analysts analyze files which are noted as high or large (by 6 p.m. on the day following deployment) by calculating an approximate monthly kWh from meter change date divided by number of days (between previous read and meter change) and evaluating relative to previous month and prior year kWh history, as well as weather conditions and tenant history. If calculated monthly kWh is materially different from the previous month and prior year history, an exception is created for review prior to acceptance of the final out-read for billing purposes.
4)	',Post Audit Validation Review/Report'	The ',Post Audit Review/Report' process identifies bills that are potentially high. The ',Post Audit Review' validation is based on a comparison of current month kWh with previous month and prior year kWh, as well as comparison to certain customer rate codes. The ',Post Audit Report' is produced daily and reviewed by billing analysts each morning to identify instances where the current month kWh is inconsistent with previous month and prior year kWh accounting for weather conditions and tenant history. Billing analysts may cancel the bill generated and issue a re-bill if corrective action is required.

g) Commercial Advanced Meters Demand Reset Issue – May 2010

- 1) **Discovery / description of the issue:** Oncor discovered an issue, which was reported to the Commission in May 2010, related to the 'demand reset' functionality of certain first generation commercial advanced meters. The issue was identified through inquiries from commercial customers regarding bills that reflected identical demand related charges in consecutive months. Oncor investigated each inquiry and identified that, in a number of cases, the demand registers in certain first generation commercial advanced meters, which needed to be manually reset each month, were not being reset at the end of each billing cycle.
- 2) **Number of advanced meters / customers potentially affected:** Oncor identified and reported a total of 9,739 first generation commercial advanced meters were impacted by this issue.
- 3) **Estimate of potential impact to customers:** Oncor reviewed the customer bills for each of the 9,739 first generation commercial advanced meters and determined a potential impact that varied from \$0.04 to over \$8,000, with an average impact of \$75.08.
- 4) **Number of erroneous bills produced:** Oncor reported that a total of 23,670 erroneous bills were produced related to the 9,739 first generation commercial advanced meters. Oncor corrected the erroneous bills as they were identified.
- 5) **Root cause analysis and corrective action:** Oncor determined that this issue resulted from human error as it was known that these first generation commercial advanced meters required a manual demand reset. Oncor will deploy a firmware patch that will automate the Demand Reset function for these meters in the fall of 2010. However, Oncor instituted an interim manual process in April 2010 to ensure that this issue does not occur again prior to the deployment of the firmware patch. The interim manual process and associated control points are detailed and assessed in *Table 35* below.

No.	Control Point Owner	Description	Assessment
1)	Oncor	List of meters requiring demand reset generated from the Meter Data Management System (MDMS) and reviewed by Measurement Services (MS) before being forwarded to Landis+Gyr on cycle-day-minus-1 for remote reset scheduling.	Control point ensures current list of meters requiring demand reset is generated daily.
2)	Landis+Gyr	Remote demand reset attempted on all meters on list on cycle day. Count of successful and list of unsuccessful remote resets generated by Landis+Gyr is sent to MS and Revenue Management (RM) on cycle day for reconciliation.	Control point ensures current list of meters successfully reset is reviewed daily.
3)	Oncor	MS creates field orders for manual demand reset on all un-reset meters	Control point ensures manual reset is scheduled daily for un-



		with demand. MS monitors field orders for timely completion.	reset meters.
4)	Oncor	Count of successful and list of unsuccessful manual resets generated by MS is sent to RM on , cycle-day-plus-3-business-days' ( ,RM & MS reconciliation '). RM flags un-reset accounts in LCIS for manual bill calculation.	Control point ensures manual reset success rates are monitored and manually generated bills are scheduled for calculation as needed.
5)	Oncor	Report for , peak demand time stamp within cycle' run by MS on last day of billing cycle ( ,RM reconciliation '). Un-reset meters manually billed through normal re-bill process.	Control point ensures un-reset meters are manually billed through normal re-bill process.
6)	Oncor	, Same-demand-for-three-consecutive-months' validation point in LCIS exception process.	Control point ensures any meters showing identical demand for three (3) consecutive months are identified through LCIS exception process.

2. CenterPoint Related Issues

a) Load Profile Saturation Issue – February 2010

- 1) **Discovery / description of the issue:** CenterPoint discovered an issue, which was reported to the Commission in February 2010, related to a higher than normal number of , load profile saturation flags' that impacted the register of electricity usage recorded by certain advanced meters. The issue was identified through CenterPoint's standard control points and validation checks included in its meter data management process. CenterPoint's meter data management process includes a number of validation checks that are automatically performed in accordance with the Uniform Business Practice standards for advanced metering validation, estimation, and editing. One (1) of these validations checks is a , pulse overflow' (or, as reported to the Commission, , Load Profile Saturation ') validation that ensures any meter data records with a pulse overflow (i.e., the advanced meter's memory space is full and historical meter events and electricity usage data is overwritten by new meter events and electricity usage data) is identified for manual review by a billing analyst, as well as the physical meter testing and maintenance. CenterPoint investigated the pulse overflow events and identified that the interval data for each of the advanced meters included a single 15-minute interval with a value of 65.535 kWh, which is the maximum number of pulses allowed in an interval. This , Pulse Overflow' event resulted in a higher-than-actual kWh usage to be recorded and communicated to CenterPoint's advanced metering system for approximately 3,500 of the advanced meters.
- 2) **Number of advanced meters / customers potentially affected:** CenterPoint identified and reported a total of 10,656 advanced meters were impacted by this issue as of May 2010. This represented 2.7% of the 397,136 advanced meters installed as of May 31, 2010.

- 3) **Estimate of potential impact to customers:** CenterPoint reviewed the customer bills for each of the 10,656 advanced meters that were affected by this issue. The 65.535 kWh value recorded in the single 15-minute interval was added to the register read communicated from approximately 3,500 of the advanced meters to CenterPoint's advanced metering system. As a result, a customer's bill could have been potentially increased by 65.535 kWh during the period of the pulse overflow. Based on average residential electricity consumption in Texas, a 65.535 kWh increase in electric usage may reflect a 5% to 8% increase in a customer's monthly electric bill.
- 4) **Number of erroneous bills produced:** While 10,565 advanced meters were impacted by this issue, not all customer bills were impacted as only approximately 3,500 of the advanced meters communicated erroneous electricity consumption information to the advanced metering system as well as certain timing differences related to billing cycles. CenterPoint reported that a total of 3,435 erroneous bills were produced related to the 'Pulse Overflow' issue. CenterPoint corrected the erroneous bills as they were identified.
- 5) **Root cause analysis and corrective action:** CenterPoint, in conjunction with Itron, developed an identification and resolution process for this issue. CenterPoint identified approximately 125,000 advanced meters with a certain package combination of hardware, software and firmware (hardware version 2.0, operating system 2, and firmware Service Pack 3) that were susceptible to this issue which was caused when a synchronization time-out occurs on the advanced meter. While only 10,656 of the advanced meters were impacted by the pulse overflow issue, CenterPoint and Itron created a short-term solution for all 125,000 advanced meters that were potentially susceptible. A firmware update, or 'patch', which limited the data stored on the meter to 50 days (from the previous 376 days) was delivered through the advanced metering system to all 125,000 advanced meters to significantly reduce the likelihood of synchronization time-outs occurring on any additional advanced meters. In addition, CenterPoint replaced all 10,656 advanced meters with advanced meters that had updated firmware installed (Hardware Version 2.0, Service Pack 5) which also significantly reduced the likelihood of the occurrence of the pulse overflow issue. As a long-term solution, CenterPoint is currently evaluating and testing an operating system and firmware package upgrade for all advanced meters which would, among other items, resolve the pulse overflow issue permanently. The new operating system and firmware is scheduled for deployment in the next 12 months.

### 3. AEP Texas Related Issues

AEP Texas had not identified any significant issues relating to its advanced meter deployment as of June 30<sup>th</sup>, 2010. However, one (1) advanced meter subjected to the Side-by-Side Testing with MET Labs as previously described in Section V of this Report, did not perform as expected.

#### a) Advanced Meter Failure Issue – July 2010

- 1) **Discovery / description of the issue:** Navigant Consulting identified one (1) advanced meter during the Side-by-Side Testing that did not perform as expected. Specifically, the advanced

- meter failed to accurately register and record electric usage during the winter sequence of the Side-by-Side Testing.
- 2) **Number of advanced meters / customers potentially affected:** As of the date of this Report, AEP Texas had not identified any other advanced meters that had failed to accurately register and record electric usage during their deployment of advanced meters and advanced metering system.
  - 3) **Estimate of potential impact to customers:** AEP Texas currently believes that there has been no impact to customers as the advanced meter in question failed during the independent Side-by-Side testing conducted by Navigant Consulting.
  - 4) **Number of erroneous bills produced:** AEP Texas also currently believes that no customer bills have been impacted as a result of the advanced meter failure in question.
  - 5) **Root cause analysis and corrective action:** As of the date of this report, AEP Texas and Landis+Gyr are continuing to investigate the potential causes for observed failure of the advanced meter in question. In addition, AEP Texas is also reviewing the customer bills for the premise where the advanced meter in question was installed. Any anomalies in customer billing that are inconsistent with expected will be analyzed and addressed by AEP Texas.

It also should be noted that, as with all large scale technology deployments, AEP Texas has identified a number of required software and firmware enhancements. Each has been prioritized and scheduled for remediation in an orderly manner through the normal cycle of software and firmware version updates typical of deployments of this nature.

For example, Command Center Service Pack 2 (SP2) version 4.1.1.56 from Landis+Gyr, incorporates several enhancements and defect resolutions. A portion of the enhancements and defect resolutions in SP2 were items found during AEP's System Acceptance Testing (SAT) performed in January and February, 2010. Some of the items that were found in the SAT that the SP2 release will address include: 1) interval read recovery packet shift; 2) Daylight Saving Time interval count; and 3) AES encryption by default for encrypted systems (enabled). Command Center Service Pack 2 (SP2) will be deployed in August 2010.

In addition, during the fourth quarter of 2010, AEP Texas plans to update its Command Center software with Command Center version 5.0 from Landis+Gyr. This version will be a full system release that incorporates several new features, enhancements and issue resolutions. In addition to an enhanced security module, this release will enable high speed network and initial endpoint devices to increase network bandwidth and speed, as well as support for C12.22 end-to-end and IP addressability<sup>97</sup>. This system release will also include enhanced meter platform revisions for the Focus AX modular as well as the integrated meter platform, enhanced support for SEP 1.0, CIM 61968 and Network Management features.

<sup>97</sup> ANSI C12.22 is the designation of a new standard being developed to allow the transport of ANSI C12.19 table data over networked connections. ANSI C12.19 provides the data model for advanced meters.