



## **Final Technical Report**

**DE-OE0000033**

**Long Island Power Authority**

**Long Island Smart Metering Pilot Project**

**April 30, 2012**

## Table of Contents

<b>1.0</b>	<b>Executive Summary.....</b>	<b>1</b>
<b>2.0</b>	<b>Comparison of Accomplishments with Project Goals and Objectives .....</b>	<b>2</b>
2.1.	The Project Goals and Objectives.....	2
2.2.	The Project Results and Accomplishments .....	4
2.2.1.	Testing of AMI Functionality .....	5
2.2.2.	Testing of Customer Acceptance of AMI and TOU Pricing.....	5
<b>3.0</b>	<b>Summary of Project Activities.....</b>	<b>7</b>
3.1.	LIPA's Hypothesis – What LIPA Expected .....	7
3.2.	LIPA's Results – What LIPA Saw .....	7
3.3.	Project Activities, Approaches, and Problems Encountered Relating to AMI Deployment and Testing – SOPO Tasks 1, 2, and 4 .....	14
3.3.1.	Bethpage Pilot Area Deployment.....	16
3.3.2.	Hauppauge Pilot Area .....	17
3.3.3.	Assessment of Problems and Impact on Project Results – Bethpage AMI Deployment .....	18
3.3.4.	Assessment of Problems and Impact on Project Results – Hauppauge AMI Deployment .....	19
3.4.	Project Activities, Approaches, and Problems Encountered Relating to System Testing Activities – SOPO Tasks 2 and 6 .....	19
3.4.1.	Problems Encountered and Departure from Planned Methodology .....	22
3.5.	Project Activities, Approaches, and Problems Encountered Relating to Voluntary Customer Participation in TOU Pricing – SOPO Task 3 .....	23
3.5.1.	Customer Solicitation and Education Activities and Approaches .....	23
3.5.2.	Problems Encountered and Departure from Planned Methodology .....	24
3.5.3.	Assessment of Problems and Impact on Project Results Relating to TOU Pricing .....	28
3.6.	Project Activities, Approaches, and Problems Encountered Relating to Meter Data Management System Specification Development – SOPO Task 5 .....	28
3.6.1.	Problems Encountered and Departure from Planned Methodology .....	29
3.6.2.	Assessment of Problems and Impact on Project Results.....	29
3.7.	Other Lessons Learned .....	29
3.7.1.	Meter Deployment .....	29
3.8.	Project Activities, Approaches, and Problems Encountered Relating to Project Management and Reporting – SOPO Task 1.....	29
3.8.1.	Project Activities and Approaches .....	30
3.8.2.	Problems Encountered and Departure from Planned Methodology .....	30
3.8.3.	Assessment of Problems and Impact on Project Results.....	30
<b>4.0</b>	<b>Products Developed .....</b>	<b>31</b>
<b>5.0</b>	<b>Computer Modeling.....</b>	<b>32</b>

## List of Figures and Tables

### **Figures:**

Figure 3-1. Changes in Energy Usage by TOU Customers in Pilot .....	8
Figure 3-2. Peak Usage as a Percentage of Total Consumption by Participants (2010) .....	9
Figure 3-3. Peak Usage as a Percentage of Total Consumption by Participants (2011) .....	9
Figure 3-4. Customer Savings (2010).....	10
Figure 3-5. Customer Savings (2011).....	11
Figure 3-6. Percentage Customer Savings (2010).....	12
Figure 3-7. Percentage Customer Savings (2011).....	12
Figure 3-8. Comparison of Average Hourly Demand on 2010 Summer Day in Bethpage Pilot Area ..	13
Figure 3-9. Comparison of Average Hourly Demand on 2010 Peak Summer Day in Bethpage Pilot Area.....	14
Figure 3-10. Example of Bethpage Web Tool Display .....	25
Figure 3-11. Example of Vendor B Hauppauge Web Tool Display.....	26
Figure 3-12. Customer Satisfaction with Pilot .....	28

### **Tables:**

Table 2-1. Accomplishment of Major Elements of Objectives .....	4
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## 1.0 Executive Summary

The Long Island Power Authority (LIPA) Smart Meter Pilots provided invaluable information and experience for future deployments of Advanced Metering Infrastructure (AMI), including the deployment planned as part of LIPA's Smart Grid Demonstration Project (DE-OE0000220). LIPA will incorporate lessons learned from this pilot in future deployments, including lessons relating to equipment performance specifications and testing, as well as equipment deployment and tracking issues.

LIPA ultimately deployed three AMI technologies instead of the two that were originally contemplated. This enabled LIPA to evaluate multiple systems in field conditions with a relatively small number of meter installations. LIPA experienced a number of equipment and software issues that it did not anticipate, including issues relating to equipment integration, ability to upgrade firmware and software "over the air" (as opposed to physically interacting with every meter), and logistical challenges associated with tracking inventory and upgrade status of deployed meters.

In addition to evaluating the technology, LIPA also piloted new Time-of-Use (TOU) rates to assess customer acceptance of time-differentiated pricing and to evaluate whether customers would respond by adjusting their activities from peak to non-peak periods. LIPA developed a marketing program to educate customers who received AMI in the pilot areas and to seek voluntary participation in TOU pricing. LIPA also guaranteed participating customers that, for their initial year on the rates, their electricity costs under the TOU rate would not exceed the amount they would have paid under the flat rates they would otherwise enjoy.

62 residential customers chose to participate in the TOU rates, and every one of them saved money during the first year. 61 of them also elected to stay on the TOU rate – without the cost guarantee – at the end of that year. The customer who chose not to continue on the rate was also the one who achieved the greatest savings. However, after the first year, the customer in question installed equipment that would have made TOU rates a more costly option than the residential flat rate. During the second year, all but one customer saved money. That customer increased usage during peak hours, and as a result saw an increase in annual costs (as compared to the flat rate) of \$24.17. The results were less clear for commercial customers, which LIPA attributes to rate design issues that it will take into account for future deployments.

LIPA views this pilot as a complete success. Not only is LIPA better prepared for a larger deployment of AMI, but it is confident that residential customers will accept AMI and TOU rates *and* shift their energy consumption from peak to non-peak periods in response to pricing. On a larger scale, this will benefit LIPA and all of its customers by potentially lowering peak demand when energy costs are highest.

## 2.0 Comparison of Accomplishments with Project Goals and Objectives

### 2.1. The Project Goals and Objectives

The Statement of Project Objectives for the Project (the “SOPO”) identifies the following goals:

The objective of the pilot project is to test the functionality of Advanced Metering Infrastructure (AMI) technology and its interaction with existing components of the LIPA T&D [transmission and distribution] system, (e.g., automated switches, Power Line Carrier, mesh technology, fixed and mobile radio). The project encompasses the ability to collect meter information (e.g., interval energy use) using the new technology, to detect system conditions, including load and usage within the system, and to send control signals to equipment situated within the distribution system. The project will study the performance of alternative AMI communications schemes and technologies to determine the most cost effective technology for use in full-scale deployment across LIPA’s system.

The project will test customer acceptance and response to enhanced energy use information and dynamic (i.e., time-differentiated) pricing. The project results will assess the use of “in-premises” web-enabled information portals or similar devices including strengths and weaknesses in influencing customer behavior. The project will determine the degree to which customers respond to time of use prices by reducing consumption during higher cost periods or shifting consumption to the lower-cost off-peak hours, and how customers react to variations in pricing structures (i.e., the length of on-peak and off-peak periods, and pricing differentials).

These objectives will require the ability to share meter information with the customer on a near real-time basis and to provide pricing signals to the customer.

Six tasks were identified to support these objectives, providing the blueprint for the project.

**Task 1.0- Develop Project Management Plan:** System configurations and requirements shall be prepared that define full meter functionality, communication networks, in-home devices, web portals, and distribution automation opportunities. Related costs and legal issues shall be identified. A project management plan shall be prepared that captures these insights and shall be used to manage project schedule, costs, quality, and deliverables.

**Task 2.0 - Identify Meter Issues:** Meter issues shall be identified including possible meter manufacturers, meter functionality, meter deliverables, and meter communication protocols for each vendor in the pilot. Each meter recommended by a vendor shall be assessed to assure it meets ANSI [American National Standards Institute] standards and is acceptable under the New York State Public Service Requirements. Additionally, meter functionality shall be tested to assure the meter will communicate with vendor networks and In-Home Devices (IHDs). Meters shall be programmed and installed at residential and commercial customers. Meter

communications and communication paths to IHDs shall be tested and confirmed to validate minimum functional requirements including the ability to electronically transmit meter data such as consumption, voltage, demand, and time of use data.

**Task 3.0- Test Market:** The potential for encouraging customers to change their user habits shall be tested by offering more information relative to their consumption, time of use rates and real-time pricing capabilities. A marketing plan shall be prepared. Customers shall be solicited to join the pilot. The Company shall provide tools to customers to control consumption, offer varying rate structures to entice consumption of off-peak demand hours. Web tools shall be made available to customers. Data shall be captured to track the impact of the additional consumption and pricing information on customer behavior. The project shall provide detailed data on customer consumption behavior in response to the additional consumption and pricing data provided by AMI.

**Task 4.0- Install Meters:** Based upon customer requests to participate in the pilot project, a schedule shall be established for installing meters. Field work shall then be conducted that support meter installation.

**Task 5.0- Manage Meter Data:** A meter data management system shall be developed to manage the large volume of data expected from the meters as well as providing data verification. An IT [Information Technology] Project Management and scoping team shall be assigned to perform the data investigation requirements and to review various MDM [Meter Data Management] vendor and system capabilities. System requirements, a list of vendors shall, and an RFP [Request for Proposal] document shall be prepared.

**Task 6.0- Execute System Testing:** Upon pilot system installation, operational testing of the system shall be performed to assure expected results are achieved. Through a rigorous testing method, system strengths and weakness shall be identified to best prepare for final vendor selection for full system roll-out. Strengths and weakness of two independent technologies shall be determined. Lessons learned shall be integrated into a system-wide RFP.

## 2.2. The Project Results and Accomplishments

**Table 2-1. Accomplishment of Major Elements of Objectives**

Objective	Element	Completed
<b>Test AMI Functionality</b>	<b>Vendor A</b>	
	Install equipment in LIPA Lab	Yes
	Test & evaluate equipment in LIPA Lab	Yes
	Install equipment in field	Yes
	Test & evaluate equipment in field	Yes
	<b>Vendor B</b>	
	Install equipment in LIPA Lab	Yes
	Test & evaluate equipment in LIPA Lab	Yes
	Install equipment in field	Yes
	Test & evaluate equipment in field	Yes
	<b>Vendor C</b>	
	Install equipment in LIPA Lab	Yes
	Test & evaluate equipment in LIPA Lab	Yes
	Install equipment in field	Yes
	Test & evaluate equipment in field	Yes
<b>Operate Capacitor Bank Controller via AMI Communications</b>	<b>Vendor A</b>	
	Install Cooper Controller in LIPA Lab	Yes
	Integrate with AMI communications	Yes
	Test & evaluate equipment in LIPA Lab	Yes
	Install S&C Intellicap Controller in LIPA Lab	Yes
	Integrate with AMI communications	Yes
	Install S&C Intellicap Controller in field	Yes
	Integrate with AMI communications	Yes
	Test & evaluate equipment in field	Yes
	<b>Vendor C</b>	
	Install S&C Intellicap Controller in LIPA Lab	Yes
	Integrate with AMI communications	Yes
<b>Test Customer Acceptance of AMI and Time-of-Use Pricing</b>	Test & evaluate equipment in LIPA Lab	Yes
	Install S&C Intellicap Controller in field	Yes
	Integrate with AMI communications	Yes
	Test & evaluate equipment in field	Yes
	Determine Residential users with Central AC	Yes
	Pre-screen for both Central AC and Internet Access	Yes
	Market AMI and Time-of-use Rate	Yes
	Install AMI meters	Yes
	Conduct customer information meetings	Yes
	Provide tools to monitor usage	Yes

### ***2.2.1. Testing of AMI Functionality***

This objective was fully accomplished. LIPA installed, tested, and evaluated AMI technologies from three vendors. For purposes of this report, they are referred to as Vendor A, Vendor B, and Vendor C. Vendor A's mesh technology AMI system was installed in the Bethpage pilot area. It included 142 meters, two pole-top access points, and three pole-top relays. Vendor B's point-to-point technology AMI system was installed in the Hauppauge Pilot area. It included 117 meters and three pole-top data collection units. As described below, after various meter communications and other issues were encountered, LIPA replaced Vendor B's AMI system with Vendor C's mesh technology AMI system, which included 162 meters, one pole-top collector, six pole-top routers, and one wall mounted radio-frequency (RF) booster.

LIPA tested AMI functionality on all three AMI systems by:

- Collecting meter information, including both demand and consumption register reads, and receiving 15 minute interval consumption data remotely via each of the AMI systems deployed. Each system provided this data on a predetermined periodic basis, as well as on an "on-demand" basis.
- Collecting engineering data, including voltage and power outage information based on predetermined thresholds.
- Confirming two-way communications.

In addition, LIPA tested AMI functionality by operating a capacitor bank controller through Vendor A's AMI system and by demonstrating Vendor C's AMI technology's ability to operate capacitor bank controls from the shop environment.

LIPA assessed the strengths and weaknesses of not two, but three independent technologies, and captured lessons learned for subsequent AMI deployments.

### ***2.2.2. Testing of Customer Acceptance of AMI and TOU Pricing***

This objective was fully accomplished. TOU rates were offered to all of the residential customers in the pilot. To overcome customer concerns relating to lack of historic consumption information, LIPA offered prospective residential participants a one-year guarantee that their overall costs under TOU rates would not exceed the costs they would have incurred under the flat rate that would otherwise apply. 54 percent of these customers elected to participate in the trial TOU rate structure. At the end of the one-year guarantee period, all of the participating customers elected to stay on the TOU rate.

The TOU rate structure offered in the project featured a lower energy cost during off-peak hours and a higher energy cost during peak hours (weekdays from 2:00 p.m. to 7:00 p.m.). This modified rate structure provided participants with the opportunity to control their energy costs by shifting their use of higher energy-use equipment, like air conditioners, pool pumps, dishwashers, and clothes washers/dryers, to lower-cost off-peak hours.

Participating residential customers were offered web-enabled portals and hand-held home area network devices showing historical and near real-time usage data. Each participating customer's usage was analyzed after their one-year anniversary on the TOU rate to determine whether or not the customer saved on the TOU rate. Every customer on the TOU rate saved, with an average savings of \$157 per customer. With a single exception, all residential customers who participated voluntarily in the TOU rate chose to remain on the TOU rate at the end of the one-year trial period, further confirming the potential for AMI and TOU pricing to gain customer acceptance, and to deliver customer response and sustainable changes in energy consumption patterns.

## 3.0 Summary of Project Activities

### 3.1. LIPA's Hypothesis – What LIPA Expected

LIPA hypothesized that deployment and use of AMI and TOU pricing would have the following benefits:

- Improved distribution system reliability through two-way communication with grid devices; and
- Reduction of demand during peak hours.

This hypothesis assumed that LIPA would engage in customer communication and education activities and would also provide IHDs or access to web portals so that customers could understand the relationship between their consumption activities and costs. This would enable customers to manage their energy costs while reducing demand on the system during peak hours.

LIPA also sought to identify the strengths and weaknesses of two independent technologies and to capture lessons learned for subsequent AMI deployments. As part of this process, in addition to evaluating communications to meters, LIPA would evaluate communications to other devices on the distribution system such as capacitor banks.

### 3.2. LIPA's Results – What LIPA Saw

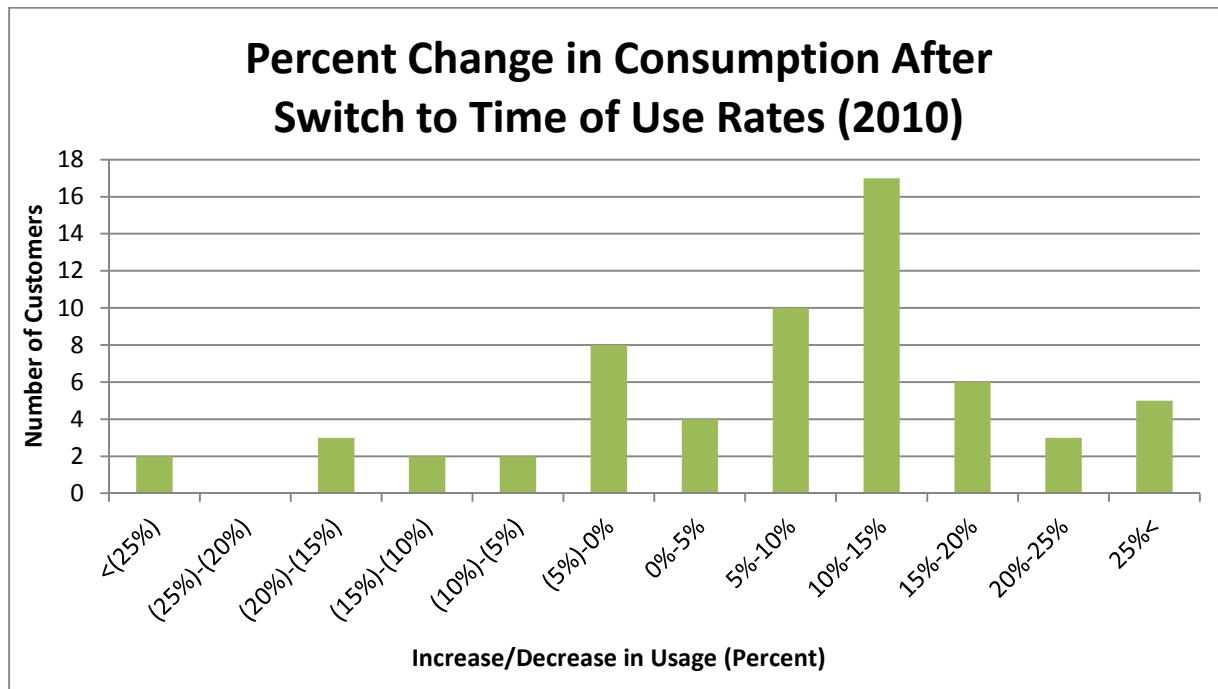
As discussed above, LIPA successfully demonstrated the potential for increased reliability in terms of the ability to monitor system conditions, collect data, and remotely control distribution devices. In addition, LIPA observed that every residential customer enrolled in the TOU pricing successfully managed energy consumption to achieve cost savings in the first year, and all but one customer did so in the second year. Significantly, these savings came despite an overall increase in energy consumption by these customers in the first year:

- Nearly 73 percent of customers increased usage after switching to TOU rates.
- On average, customers increased usage by 759 kilowatt-hours (kWh; average based on net of increases and decreases).
- Usage collectively increased over 47,000 kWh.
- The greatest increase in consumption exceeded 3,000 kWh.
- The greatest decrease in consumption exceeded 4,100 kWh.

In the second year, overall consumption was lower, but approximately 46 percent of customers increased their usage during peak hours. Nonetheless, customers continued to save as compared to flat

rates. The following graph shows the change in consumption during the first year after election to participate in TOU rates.<sup>1</sup>

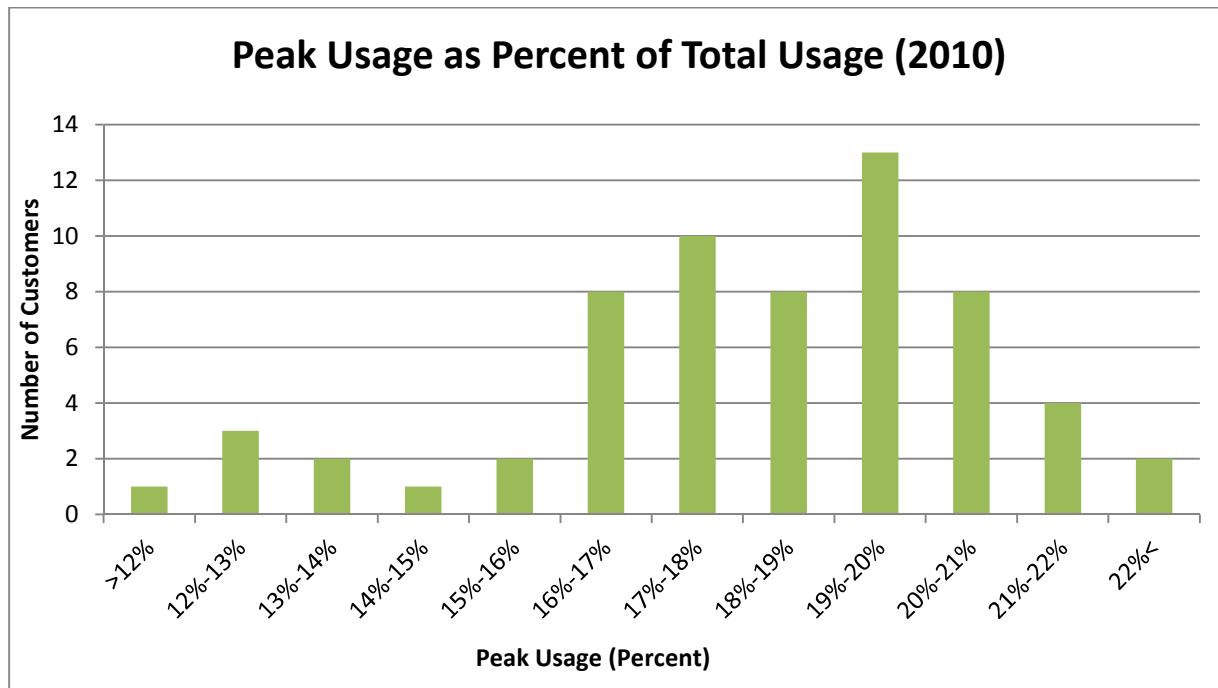
**Figure 3-1. Changes in Energy Usage by TOU Customers in Pilot**



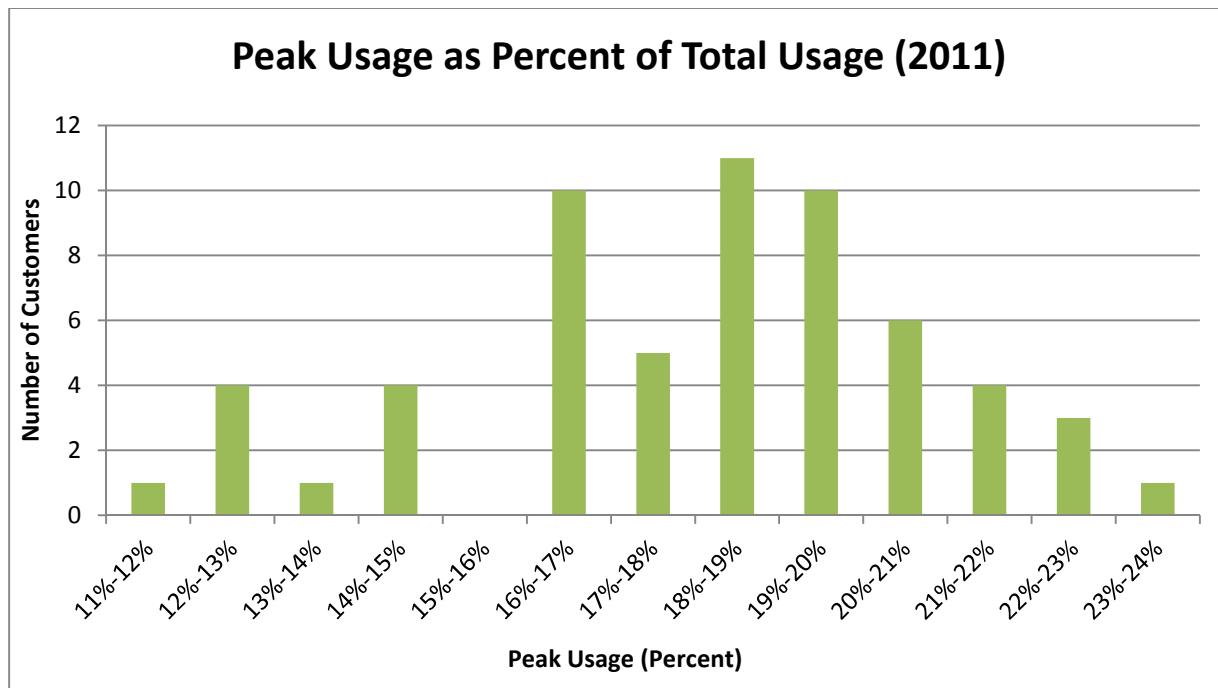
The following charts show TOU participants' peak usage as a percent of total consumption. During the first year, the average participant's peak usage was 18.2 percent of total consumption, with the minimum and maximum being 10.4 percent and 25.1 percent, respectively. During the second year, the average participant's peak usage was 18 percent of total consumption, with the minimum and maximum being 11 percent and 23.3 percent.

<sup>1</sup> All of the graphs and charts in this section, other than Figure 3-8 and Figure 3-9, present the results for the pilot area customers who participated on time of use rates (i.e., 62 customers in 2010 and 61 in 2011). Figure 3-8 and Figure 3-9 present information based on the participants in the Bethpage pilot area only.

**Figure 3-2. Peak Usage as a Percentage of Total Consumption by Participants (2010)**

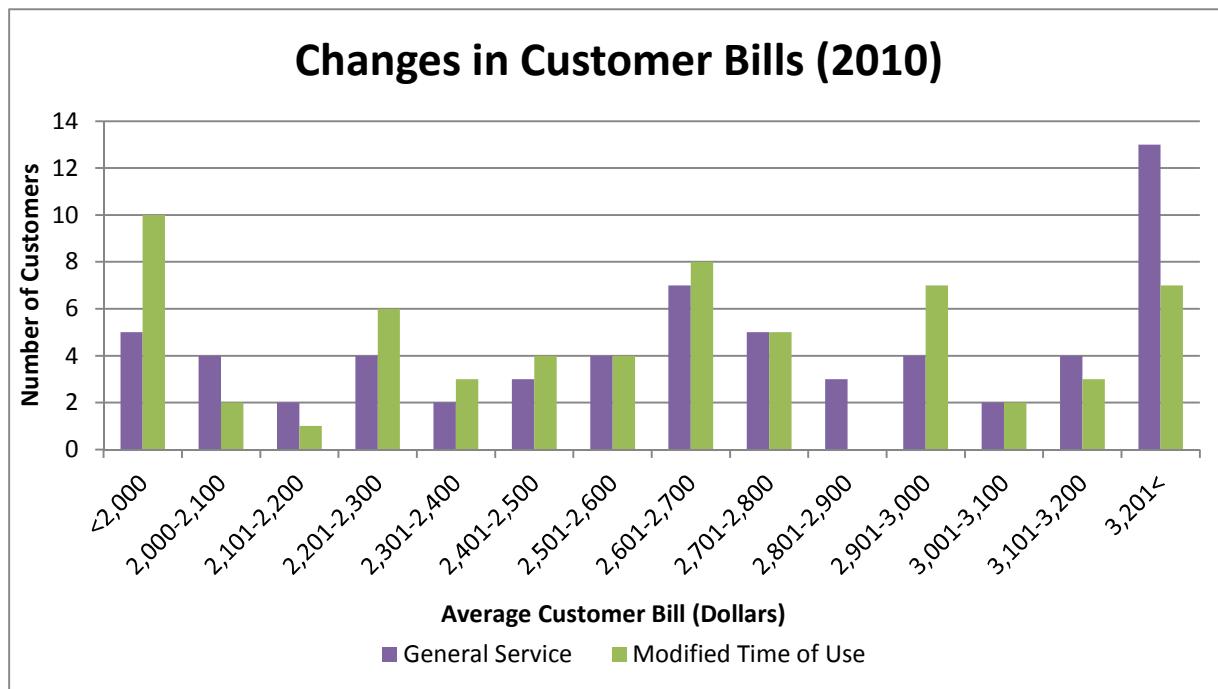


**Figure 3-3. Peak Usage as a Percentage of Total Consumption by Participants (2011)**

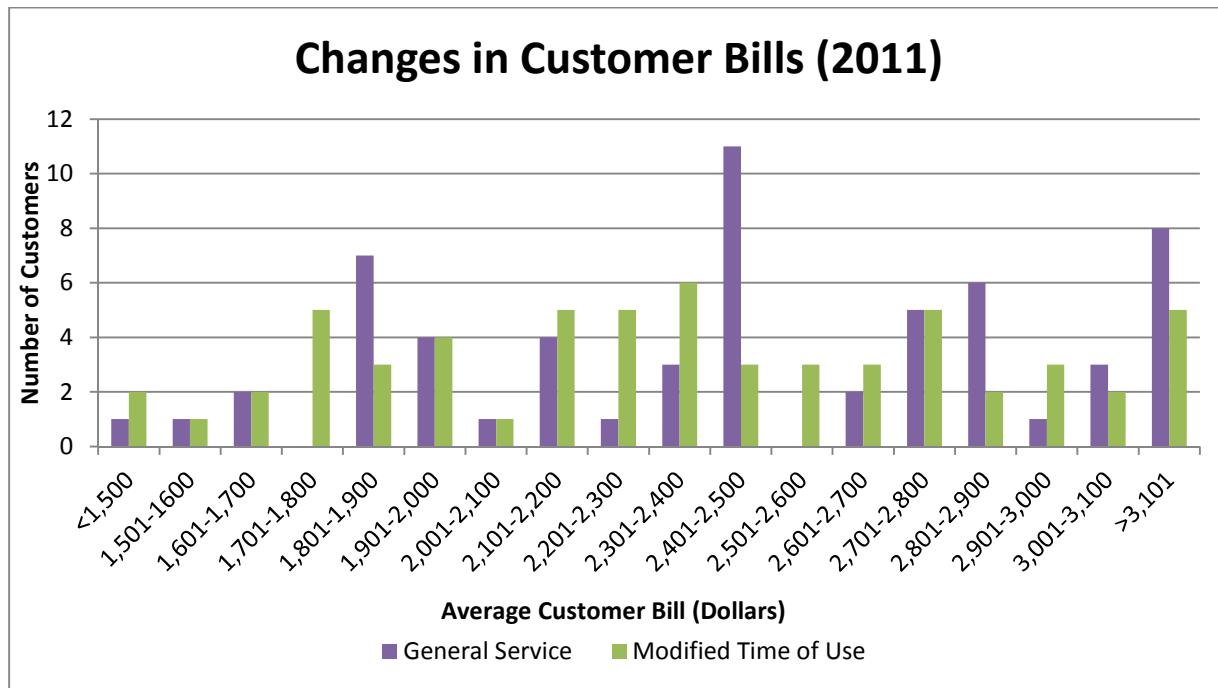


As noted, all residential participants in TOU pricing realized savings during the first year of the pilot, and all but one saved during the second year. There did not appear to be a correlation between total consumption and realized savings. However, there was a correlation between low peak consumption and increased savings. The average participant's savings during their first year of participation was \$157.27, with a minimum of \$21.78 and a maximum of \$407.78, as shown in the following figure. During the second year, the savings were slightly lower, with the average being \$131. One customer experienced an overall increase due to an increase in consumption during peak hours. Otherwise, the range of savings in the second year was \$6 to \$379.

**Figure 3-4. Customer Savings (2010)**

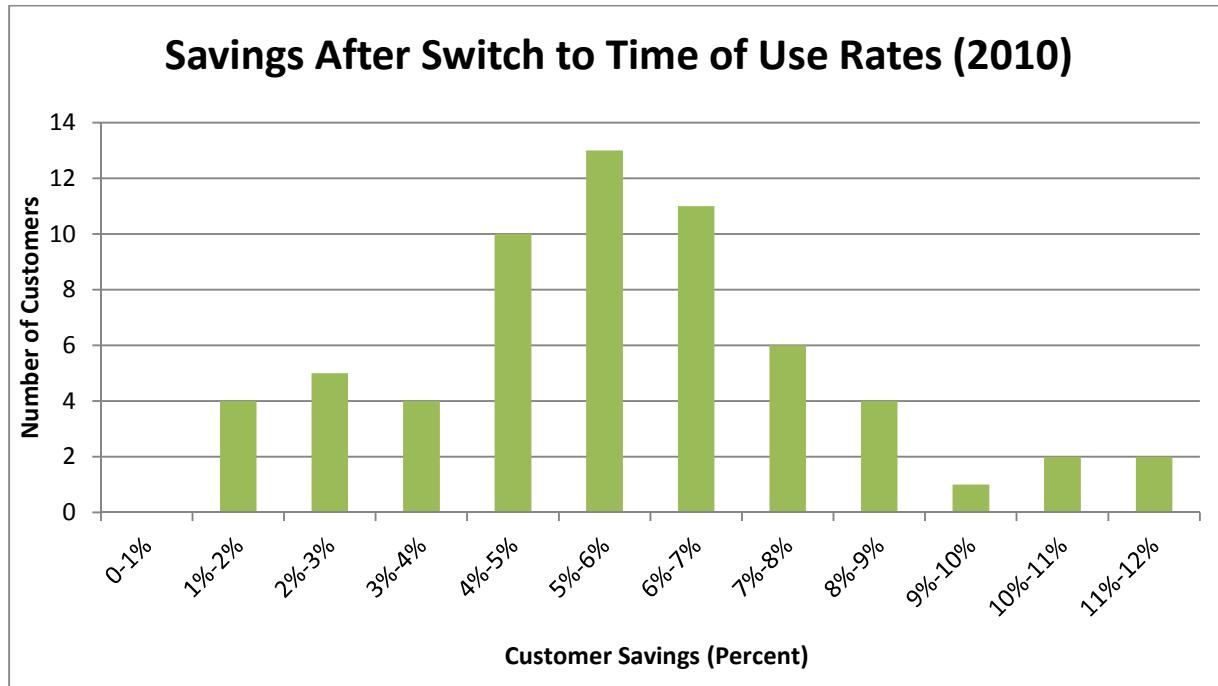


**Figure 3-5. Customer Savings (2011)**

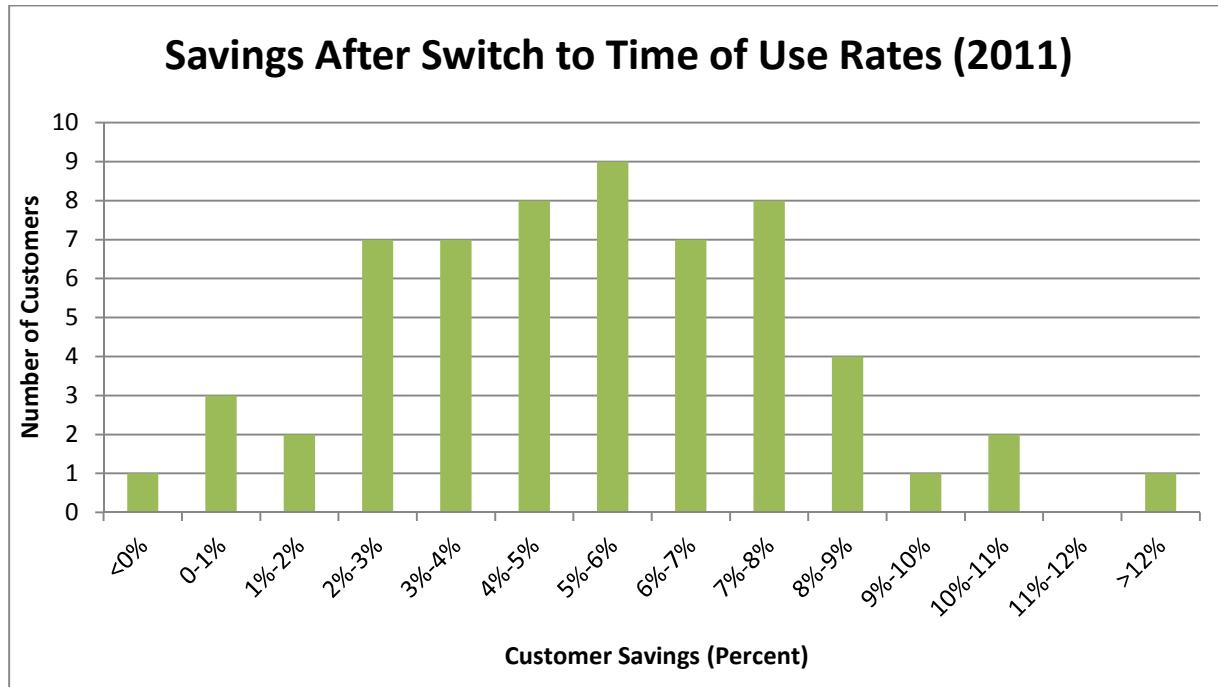


These changes in 2010 translated to savings of 1.1 percent to 12.0 percent, with the average participant saving 5.66 percent of the amount the customer would have paid on the general service rates. In 2011, the average savings was 5.14 percent, with one customer experiencing higher overall costs and other customers saving between 1.23 percent and 12.37 percent.

**Figure 3-6. Percentage Customer Savings (2010)**

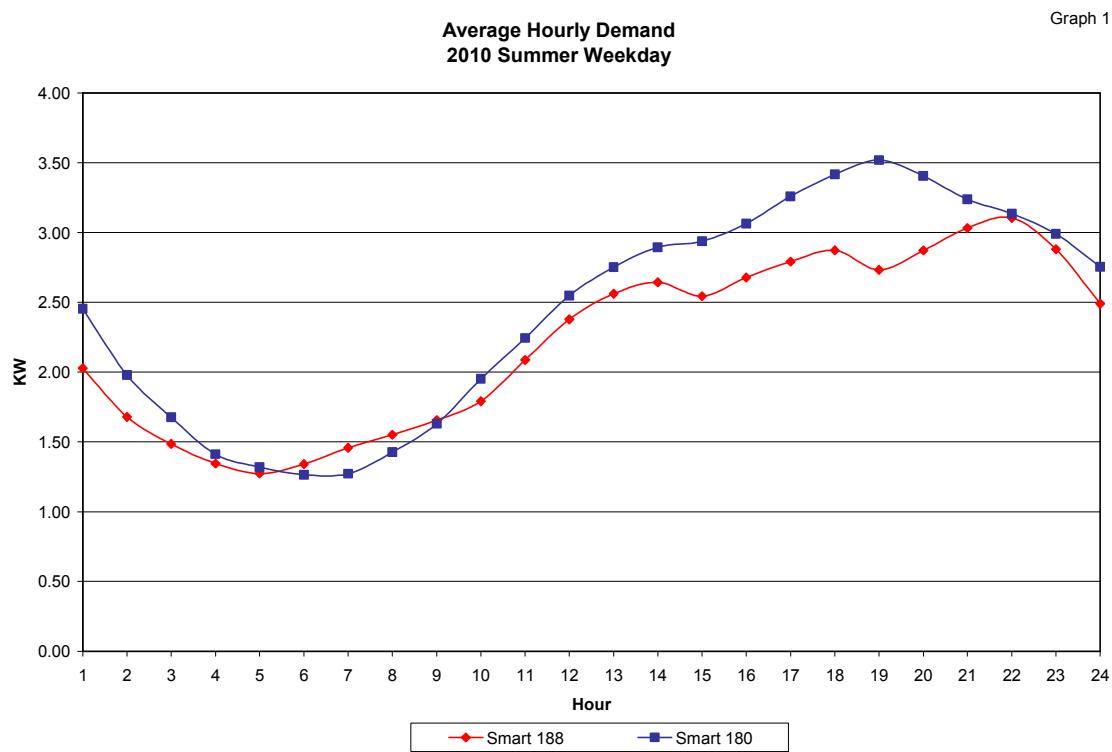


**Figure 3-7. Percentage Customer Savings (2011)**



From the small group of participants at Bethpage, LIPA saw a clear indication that residential customers were responding to TOU rates and shifting activities to lower-cost off-peak times. The following graphic shows average summer weekday hourly demand on a summer day in 2010 in the Bethpage pilot area, comparing pilot customers on the Residential Modified TOU rate used in the pilot (Rate 188) with those on the flat rate (Rate 180).

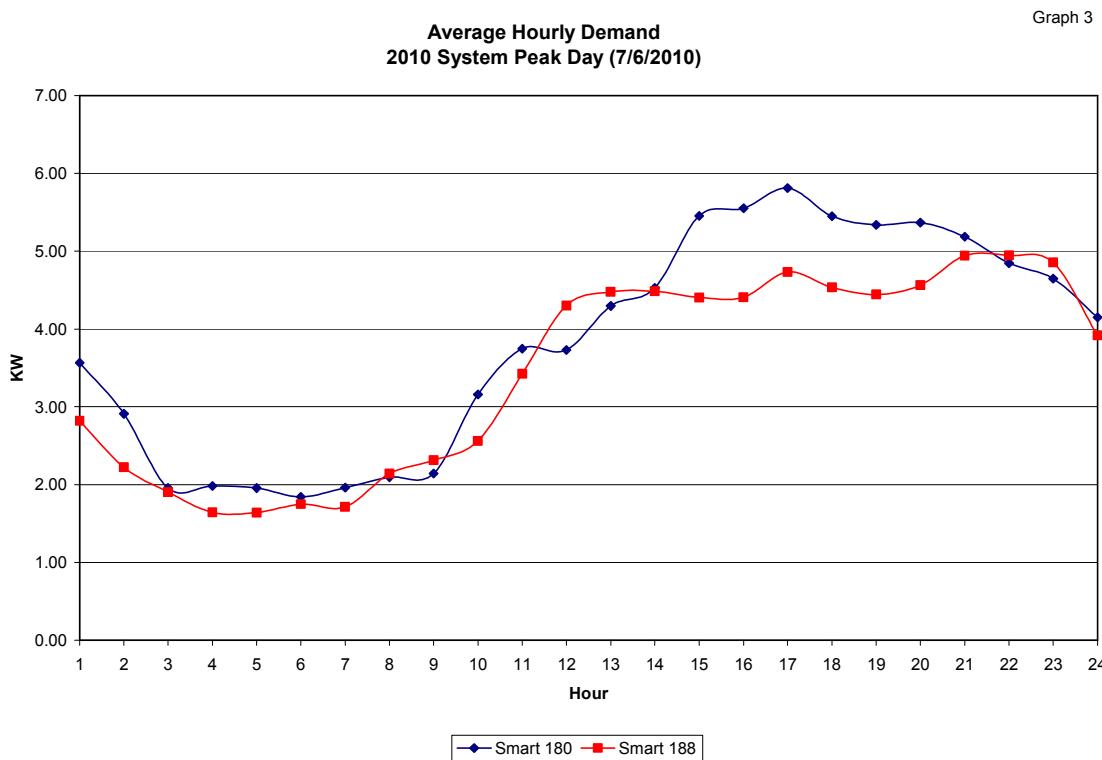
**Figure 3-8. Comparison of Average Hourly Demand on 2010 Summer Day in Bethpage Pilot Area**



The drop-off in usage from hours 2:00 to 3:00 p.m. supports the conclusion that TOU participants (i.e., those on Rate 188) are responding to peak pricing between 2:00 to 7:00 p.m. Usage for those customers drops between 2:00 and 3:00 p.m. and begins to climb between 7:00 and 8:00 p.m., peaking at 10:00 p.m. In comparison, usage by pilot customers on flat rate pricing (Rate 180) continues to rise from 3:00 p.m., peaking at 7:00 p.m.

Customer consumption patterns in the Bethpage pilot area on LIPA's 2010 peak summer day, July 6, also supports the conclusion that TOU customers were responding to peak pricing:

**Figure 3-9. Comparison of Average Hourly Demand on 2010 Peak Summer Day in Bethpage Pilot Area**



On the peak day, the Rate 180 customer load increased steadily from 9:00 a.m., peaking at 5:00 p.m. at 5.81 kilowatts (kW). In contrast, the Rate 188 (TOU) customer load increased from 8:00 a.m. until noon, leveled off from 1:00 p.m. to 8:00 p.m., peaking at 10:00 p.m. at 4.94 kW.

### 3.3. Project Activities, Approaches, and Problems Encountered Relating to AMI Deployment and Testing – SOPO Tasks 1, 2, and 4

**Task 1.0- Develop Project Management Plan:** System configurations and requirements shall be prepared that define full meter functionality, communication networks, in-home devices, web portals and distribution automation opportunities. Related costs and legal issues shall be identified. A project management plan shall be prepared that captures these insights and shall be used to manage project schedule, costs, quality, and deliverables.

**Task 2.0 - Identify Meter Issues:** Meter issues shall be identified including possible meter manufacturers, meter functionality, meter deliverables, and meter communication protocols for each vendor in the pilot. Each meter recommended by a vendor shall be assessed to assure it meets ANSI standards and is acceptable under the New York State Public Service Requirements. Additionally, meter functionality shall be tested to assure the meter will communicate with vendor networks and In-Home Devices (IHD's). Meters shall be programmed and installed at residential and commercial customers. Meter communications

*and communication paths to IHDs shall be tested and confirmed to validate minimum functional requirements including the ability to electronically transmit meter data such as consumption, voltage, demand, and time of use data.*

**Task 4.0- Install Meters:** *Based upon customer requests to participate in the pilot project, a schedule shall be established for installing meters. Field work shall then be conducted that support meter installation.*

The project team developed a project management plan in accordance with Task 1. The plan included a project schedule and contemplated the activities and issues relating to the project, including the development of detailed functional requirements and projected costs. Project management and reporting activities are discussed in Section 3.6 of this report.

The project team developed RFPs identifying the requirements to support full meter functionality, communications networks, IHDs, web portals, and/or distribution automation opportunities. All vendor responses were evaluated against the identified system configurations and technical requirements leading to the selection of several qualified vendors required to support the project. Final steps included development of contracts with each selected vendor.

The development of Scopes of Work and Terms and Conditions for each vendor took longer and was more complex than originally expected, due in part to the newness of the technology on the LIPA system. However, LIPA and the vendors moved forward with the project (ordering, building, and delivering equipment) in parallel with the finalization of Scopes of Work and Terms and Conditions. As a result, the extra time taken to finalize the Scopes and contract terms had little impact on the ultimate project schedule.

The intent of the project was to deploy fully functional meters that demonstrate the ability to electronically transmit meter data including, but not limited to, consumption, demand, time of use, and voltage data through the vendor communications networks to both LIPA and each participating customer.

LIPA conducted a thorough review of each vendor's recommended meter(s) to confirm that ANSI specifications were met and that each meter was acceptable under New York State Public Service Commission (NYSPSC) requirements. All three AMI vendors used meters from established meter manufacturers. The functionality of each meter was tested in LIPA's laboratory to ensure that the meter data was transferred to the meter's internal communications module and then to the vendor's communications network and customer's IHD (where applicable). Each meter was then programmed to the appropriate rate code structure, installed at a residential or commercial customer location, and tested to confirm transmittal of meter data through the vendor's communications network and ultimately to an IHD (for residential customers).

LIPA initially selected separate AMI systems for deployment. In the Bethpage pilot area, LIPA selected Vendor A's AMI system. In the Hauppauge Pilot area, LIPA selected Vendor B's AMI. Both Vendor A and Vendor B used meters provided by well-established meter manufacturers. As discussed below, as a result of a number of difficulties and performance issues, LIPA ultimately replaced the

AMI system and meters in the Hauppauge Pilot area with Vendor C's AMI system, which also included meters from a well-established meter manufacturer.

### ***3.3.1. Bethpage Pilot Area Deployment***

As noted above, LIPA selected Vendor A's AMI for deployment in the Bethpage pilot area. Initially, all the meters failed the factory required ANSI testing. The meter manufacturer and Vendor A worked on the issues for several months performing modifications and retesting, ultimately resolving the problem.

Initial meter deployment (99 meters) of Vendor A's technology in 2009 in the Bethpage pilot area resulted in only approximately 35 percent of the meters successfully communicating data to Vendor A's front-end software server. Analyses by Vendor A engineering identified the cause as sparse system deployment with an insufficient quantity of meters and pole-top collectors spread across a large geographic region. To correct the problem, Vendor A recommended installing additional meters and pole-top relay stations, thus bolstering the Bethpage communications network. Thirty-six additional meters and three pole-top relays were installed during 2009 and eight additional meters were installed in 2010.

Further system analysis in the first quarter (Q1) of 2010 indicated password mismatches between the meters and their associated Network Interface Cards (NICs), which created a failed communication link between the meter and Vendor A's AMI system. Investigation revealed that the mismatches were created during installation when the LIPA rate programs were loaded into meters associated with TOU rates. Correcting the password mismatches allowed for successful communication.

During Q2 2010, an abnormally high error code rate (approximately 10 percent) was also experienced with the commercial meter product associated with the Bethpage portion of the project, resulting in replacement of the meters having error codes. Investigation of the various error codes by LIPA metering and the meter manufacturer's engineering personnel indicated communication failure between the meter register and the Vendor A NIC. To prevent the error from reoccurring, the meter manufacturer issued a meter firmware upgrade that was successfully tested in LIPA's meter shop, but not delivered to meter field locations because Vendor A did not have the ability to update the meter firmware remotely at that time. Subsequently, in Q3 2011, Vendor A provided an "over-the-air" meter firmware update process for testing in LIPA's lab.

Meter and communications issues continued throughout the last three quarters of 2010, with several meters not communicating with the head-end software. Field investigations by LIPA and Vendor A's technical personnel determined that several of the meters were not emitting RF signals from the Vendor A NICs. As a result, three meters were replaced and returned to the meter manufacturer for investigation and two others were successfully reset in the field by de-energizing and repowering the meter. This allowed the Vendor A NIC to reset and re-enable communications. However, the meter manufacturer was unable to replicate the NIC "lock-up," and therefore this type of failure remains unsolved.

At the end of Q1 2010, 13 of the 138 installed meters were not communicating. Based on field investigations conducted during Q2 2010, communication problems varied. Three meters were beyond

the range of the mesh grid and were removed. The remaining ten meters were either below grade in basements or in enclosed and isolated street-level meter rooms within the associated building. Field testing during Q2 2010 indicated that strength of the 900-MHz (megahertz) signal originating from the meter NICs in the below-grade basement and street-level meter rooms was not strong enough to register on the Vendor A AMI network. Although five additional meters were installed in Q4 2010 to further bolster the mesh network, communications did not significantly improve.

During 2011, between 13 and 17 of the 143 meters were not communicating, some permanently and others intermittently. LIPA was advised by Vendor A that these types of connectivity issues can usually be resolved by installing additional meters, replacing the existing non-communicating commercial meters with a meter with an enhanced antenna, or installing an external antenna at the location (residential or commercial) to improve the RF signal. LIPA opted for the antenna fixes (internal or external).

At the end of Q2 2011, Vendor A reported that its initial prototype of the meter manufacturer's meter with an enhanced internal antenna did not perform satisfactorily and needed to be re-engineered. At present, Vendor A does not have an anticipated date of availability of the meter with the enhanced internal antenna. Vendor A provided procurement specifications for an external antenna in Q3 2011.

### **3.3.2. *Hauppauge Pilot Area***

#### **Vendor B AMI Deployment**

LIPA initially selected the Vendor B AMI system for deployment in the Hauppauge Pilot. As described below, LIPA ultimately replaced the Vendor B AMI system (including the meters used as part of the Vendor B system) with a Vendor C's AMI system using different meters. Initially the meters utilized by Vendor B passed all ANSI testing and were deployed at 111 customer locations in 2009. Each meter was equipped with a Vendor B Meter Transmission Unit (MTU) module (the meter transmission unit, which correlates to the NIC card on the mesh system installed by Vendor A in Bethpage), which transmits meter data to the pole-top Data Control Units (DCUs) via point-to-point RF technology. After installation, several of the selected meter locations experienced communications difficulties that were resolved with meter/MTU change-outs.

In 2009, Vendor B also experienced problems with meter firmware releases for the meter table data required to support the ANSI C12 data tables. Vendor B released a residential firmware upgrade for installation in late December 2009. However, the upgrade did not completely address the ANSI data table issue, although it did address other issues requiring correction. Vendor B continued working on the ANSI data table issue associated with load profile data but never resolved it.

Vendor B also reported in 2009 that the MTU communication card in the commercial meter did not have sufficient memory to support the commercial firmware upgrade; and subsequently, new commercial meters had to be developed. This would require a complete meter change out once the replacement meters became available. At the end of Q3 2010, Vendor B estimated that design, manufacturing, and acceptance testing of a replacement meter would be complete in Q4 2010 and that full manufacturing of replacement commercial meters would occur in Q1 2011. Vendor B did not meet

that promised delivery date. Instead, in Q1 2011 Vendor B reported significant delays and proposed delivery of the replacement commercial meter in Q4 2011, well beyond the summer 2011 peak period.

During Q2 2010, Vendor B announced a move to a Wi-Fi communication platform from the meter to the associated IHD device. This change would have required a complete meter change out for all residential participants in the Hauppauge Pilot area. In addition, Vendor B's move to a Wi-Fi platform would require changes to the IHD display and functionality, as well as resolution of acceptable Wi-Fi encryption/security methods. LIPA received four prototype Wi-Fi replacement residential meters, IHDs, and routers at the beginning of Q4 2010. Acceptance testing in LIPA's lab in Q4 2010 resulted in IHD hardware failures and communications issues. Vendor B had not resolved these issues as of the end of Q1 2011 and at that time estimated resolution and delivery of replacement residential meters with Wi-Fi technology, compatible IHDs, and routers at some time in Q3 2011.

#### Vendor C AMI Deployment

Because Vendor B's anticipated delivery dates for replacement meters for all commercial and residential participants fell well beyond the start of LIPA's summer 2011 peak period, LIPA considered alternate suppliers of AMI equipment for deployment in the Hauppauge Pilot area prior to beginning of the 2011 summer season. Vendor C's AMI system and equipment was selected to replace the Vendor B AMI system.

During Q2 2011, LIPA removed all of the meters associated with the Vendor B AMI and installed the Vendor C AMI system, including 162 meters, one collector, and six routers in the Hauppauge Pilot area. All but five of the 162 new meters installed in the Hauppauge Pilot area were communicating at the end of Q2 2011. Two of the non-communicating meters were in basement locations and required the installation of a booster radio to enhance the RF signal from the meters to the routers. The remaining three meters required further investigation by LIPA and Vendor C's technical personnel. During Q3 2011, the booster radio noted above was installed and all other communications issues were resolved. At the end of Q3 2011, all 162 meters installed with Vendor C's AMI system were communicating on a consistent basis.

#### ***3.3.3. Assessment of Problems and Impact on Project Results – Bethpage AMI Deployment***

The most significant problems experienced related to meter firmware and AMI module communication firmware, both embedded in the meters provided by Vendor A, and poor communications within the Bethpage mesh. When the Bethpage commercial meters experienced an abnormally high error code rate due to communication failures between the meter register and the Vendor A AMI communication card in Q2 2010, the meter manufacturer issued a meter firmware upgrade to correct the problem. This upgrade was successfully tested in LIPA's lab but could only be deployed to the field installed meters by visiting each location to apply the firmware upgrade, as the meter manufacturer had not developed an "over-the-air" meter firmware process at the time. It was not until the end of Q3 2011 that the meter manufacturer and Vendor A developed the "over-the-air" meter firmware upgrade process for LIPA to test in its lab.

Unlike the meter firmware upgrades, Vendor A was able to perform upgrades to its AMI communication module “over the air,” which was utilized several times during the pilot period to address communications issues that were resulting in the inability to deliver meter data. More rigorous acceptance testing on the vendor’s part may have eliminated these issues before they occurred. Lastly, 100 percent communication within the Bethpage mesh could not be achieved without installing additional meters or relays, or utilizing the meter manufacturer’s next generation meter with an enhanced antenna or an externally mounted antenna. Unfortunately, Vendor A could not deliver these in sufficient time for LIPA to acceptance-test units in its lab prior to field deployment and testing. These deficiencies caused delays in performing full testing and evaluation of the Vendor A AMI system and equipment during the project period. As such, Vendor A was not selected for LIPA’s next AMI pilot project.

### ***3.3.4. Assessment of Problems and Impact on Project Results – Hauppauge AMI Deployment***

#### **Vendor B AMI System**

In Q4 2009, after meter deployment, Vendor B reported that all the commercial meters it had provided to LIPA would require an upgrade to their MTU communication card in order to support ANSI C12 data table requirements. However, the MTU cards in the field installed meters did not have sufficient memory to support the required firmware upgrade and new meters would have to be developed. This would have required a full meter change out of all the commercial meters previously installed in the Hauppauge Pilot area. Initially Vendor B anticipated design and manufacturing would be completed in Q2 2010. However, this date was not met, nor were subsequent dates.

By the end of Q4 2010, the date for delivery of new commercial meters had slipped to Q2 2011, and later in 2011, Vendor B reported that the meters would not be available until Q4 2011. Similar delays were experienced for Vendor B’s residential meters, which had to be replaced due to Vendor B’s decision to use Wi-Fi technology. As a result of these delays, at the beginning of Q2 2011, LIPA selected Vendor C as a viable AMI vendor for replacement of the Vendor B AMI system and equipment. Steps to move forward with the replacement commenced immediately.

#### **Vendor C’s AMI System**

As stated above, all but five of the 162 meters installed as part of Vendor C’s AMI in the Hauppauge Pilot area were communicating at the end of Q2 2011. Two of the non-communicating meters were in basement locations and required the installation of a booster radio to enhance the RF signal from the meters to the routers. The remaining three meters required further investigation by LIPA and Vendor C’s technical personnel. During Q3 2011, the booster radio was installed and all other communications issues were resolved. At the end of Q3 2011, all 162 meters in Vendor C’s AMI system were communicating on a consistent basis.

### ***3.4. Project Activities, Approaches, and Problems Encountered Relating to System Testing Activities – SOPO Tasks 2 and 6***

**Task 2.0 - Identify Meter Issues:** *Meter issues shall be identified including possible meter manufactures, meter functionality, meter deliverables and meter communication protocols for*

*each vendor in the pilot. Each meter recommended by a vendor shall be assessed to assure it meets ANSI standards and is acceptable under the New York State Public Service Requirements. Additionally, meter functionality shall be tested to assure the meter will communicate with vendor networks and In-Home Devices (IHD's). Meters shall be programmed and installed at residential and commercial customers. Meter communications and communication paths to IHD's shall be tested and confirmed to validate minimum functional requirements including the ability to electronically transmit meter data such as consumption, voltage, demand, and time of use data.*

**Task 6.0- Execute System Testing:** Upon pilot system installation operational testing of [AMI] system shall be performed to assure expected results are achieved. Through a rigorous testing method system strengths and weakness shall be identified to best prepare for final vendor selection for full system roll-out. Strengths and weakness of two independent technologies shall be determined. Lessons learned shall be integrated into a system-wide RFP.

Through rigorous lab and field testing, LIPA identified AMI equipment and system strengths and weaknesses of products from several AMI metering and distribution automation vendors to best prepare for a vendor or multiple vendor selection, eventually leading to a full system roll-out. Every meter ordered and received was subjected to extensive quality control testing in the LIPA Electric Meter Shop prior to field installation.

Each meter underwent routine visual inspection and accuracy tests where results were electronically stored to establish a received baseline. The meters were programmed with specific billing rate parameters.

Meter functionality features that were tested as part of this testing program included:

1. The system provided on-demand remote meter reading of individual meters or group(s) of meters;
2. The system was flexible in its ability to support multiple meter types from various meter manufacturers;
3. The system provided daily reads of at least 99.5 percent of all installed meters during non-storm situations. This included communications to all endpoint devices and their related collector/concentrators;
4. The system provided online monitoring of the system performance, including monitoring of data packets transferred, real-time configuration status reporting, measurement of performance statistics, and data collection to ensure that all performance requirements are met;
5. The system was able to support direct access to meter data for all customer segments;
6. The system was able to detect and flag meter failures;
7. All communications transmissions were required to be encrypted from end to end and required to be compliant with current North American Electric Reliability Corporation (NERC) cyber security standards, as set forth in NERC's Urgent Action Standard 1200;
8. The system provided support for remote connect/disconnect capability of the meter;
9. The system provided adequate redundancy in design such that the data from a meter can be retrieved in the event of hardware/communications failure; and

10. The system provides anti-theft detection and provided reporting for tampered conditions.

Lab testing of the communications between meters and pole-top collection units was also conducted prior to installing the pole-top units. After installation in the field, similar testing between meters and pole-top collectors was conducted. Additional test routines designed to examine the system capabilities and stress testing were developed with each AMI vendor.

Field testing of communications between meters and the pole-top collectors followed lab testing. Testing tools included laptops with evaluation software capable of determining signal strength at the site. A varying number of meters (between 13 and 17) in the Bethpage area are currently not communicating. Similar communications issues existed on five meters in the Hauppauge Pilot area and were addressed by LIPA and Vendor C technical personnel during Q3 2011. All 162 meters in Vendor C's AMI system were communicating at the end of Q3 2011.

The project demonstrated that the communications system can be adversely impacted by environmental conditions, geography, equipment malfunction, and interference. The introduction of latitude and longitude information for each meter location enhanced the ability to conduct system evaluations. IHD technology and the development of web-access to provide meter consumption data to the customer are prime examples of vendor related delays.

#### Distribution Automation Equipment

The project also tested two-way communications to a capacitor bank controller via the AMI system. The planned two-way communication required a master e-bridge at the front end and a slave e-bridge at the device. In order to provide two-way communication over a longer path (i.e., field installation), a relay would be required between the master and slave e-bridges.

Two capacitor bank controller vendors, S&C Electric and Cooper Power Systems, were identified as having the capability to connect to the slave e-bridge (supplied by Vendor A). Both capacitor bank controller vendors performed testing at their own facilities to verify communications were viable with their controllers (S&C IntelliCAP Capacitor Controller and Cooper CBC7000 Capacitor Controller). Based on these successful tests, LIPA then acquired an S&C IntelliCAP Capacitor Controller, S&C Programming Software, and a Cooper CBC7000 Capacitor Controller. LIPA also acquired one master e-bridge and two slave e-bridges from Vendor A and one master utilinet radio and two slave radio's from Vendor C. In addition, RTSCADA front-end software was configured to work with the Vendor A's e-bridges and Vendor C's utilinet radio to control and monitor the S&C Capacitor Controller and Cooper CBC 7000 Controller. Testing of communications among this equipment in LIPA's lab environment for both AMI vendors' mesh technology was successful and activities to support field testing commenced.

A Capacitor Controller was set up in a remote office to test the remote operation of the CBC 7000 and S&C IntelliCAP in August 2010. Full communications via a router was achieved using the RTSCADA front-end system software to successfully send "open" and "close" commands to the unit, and to monitor DNP points such as voltage, local/remote, neutral current alarm, etc.

A capacitor bank was installed in October 2010, an S&C Capacitor Bank Controller with the Vendor A slave e-bridge was installed in November 2010, and a relay was installed in December 2010. The relay was necessary to communicate with the capacitor bank controller from the office building. Later in December 2010, with the assistance of Vendor A, communications were established to control the Capacitor Controller using a metering access point, and LIPA was able to successfully “open” and “close” the capacitor bank, thereby completing testing at a field location through the Vendor A AMI system

### ***3.4.1. Problems Encountered and Departure from Planned Methodology***

System testing operated as expected. There were no problems encountered in this part of the process other than the problems identified as a result thereof. A number of issues were identified throughout each of the AMI pilots where processes fell short or where problems could arise in these and future deployments, including the following;

- Tracking of AMI module number during deployment
- Retrieving TOU data from meter index register
- Communicating with AMI devices in a sparse meter deployment
- Frequent firmware upgrades for AMI meters and collectors
- Frequent upgrades for AMI head-end software
- Support for home area network (HAN) equipment

### **Distribution Automation Equipment**

Communications links from the e-bridge to S&C IntelliCAP and the Cooper CBC Cap controllers were established to utilize the RTSCADA front-end system software. There were no major issues with the configuration and setup of the Vendor C equipment. Additionally, there was support from Vendor C that helped achieve the distribution automation requirements within a timeframe of approximately three and one-half months with minimal purchase requirements.

There were a number of issues with the configuration and setup that were addressed with Vendor A. The issues encountered included the following:

- Addressing the device
- Radio device not within signal range requiring a repeater
- Mapping of DNP points
- Use of Null Modem to establish communications

LIPA took the lead in resolving these issues with the vendor and pushed Vendor A to resolve them. As a result, the Vendor A equipment was ultimately successful in communicating and controlling the capacitor bank controllers.

### 3.5. Project Activities, Approaches, and Problems Encountered Relating to Voluntary Customer Participation in TOU Pricing – SOPO Task 3

**Task 3.0- Test Market:** *The potential for encouraging customers to change their user habits shall be tested by offering more information relative to their consumption, Time-of-Use rates, and real-time pricing capabilities. A marketing plan shall be prepared. Customers shall be solicited to join the pilot. The Company shall provide tools to customers to control consumption, offer varying rate structures to entice consumption of off-peak demand hours. Web tools shall be made available to customers. Data shall be captured to track the impact of the additional consumption and pricing information on customer behavior. The project shall provide detailed data on customer consumption behavior in response to the additional consumption and pricing data provided by AMI.*

#### 3.5.1. Customer Solicitation and Education Activities and Approaches

LIPA's objective was to encourage customers to reduce energy consumption during peak hours by offering TOU rate structures as well as providing participating customers with tools to actively monitor their energy usage. LIPA targeted customers with certain types of high energy consumption equipment, such as central air conditioning or pool pumps, and who also had access to email and the Internet. LIPA hoped to see customers respond to TOU pricing by either shifting activities to reduce energy consumption to off-peak times or by taking steps to reduce energy consumption overall.

The marketing effort started with the development of a detailed marketing plan followed by the solicitation of customers to join the pilot program. The marketing plan had four distinct phases:

Phase 1 – Solicitation and Installation:

- Pre-call letters sent to commercial and residential customers, outreach by LIPA Customer Service, economic development, and Major Account Participant “Thank You” contacts
- Inspection and installation notifications
- Inspections and installations
- Press releases and events

Phase 2 – Education:

- Explanation and solicitation for participation with the TOU rates option
- Survey of participants' satisfaction and ability to manage costs
- Web tool availability -- communications and training to commercial and residential customers
- Energy savings tips
- In-Home Device availability -- communications and training to residential customers

Phase 3 – Data Collection

- Online survey to obtain participant feedback regarding program, tools, and rates
- Roundtable groups

## Phase 4 – Data Analysis:

- Data obtained from various research initiatives to provide for program results for goal measurement as well as program process improvement, tool effectiveness, rate effectiveness, load profiles, and customer satisfaction
- Post pilot roundtable groups

Phase 1 of the marketing effort was completed by the end of Q1 2010 with the signing of more than 200 customers in the two target areas followed by inspections and the installation of meters. This phase of the campaign utilized direct mail, telephone contact, and collateral marketing material.

### ***3.5.2. Problems Encountered and Departure from Planned Methodology***

There were no significant problems encountered with respect to enrolling residential customers in TOU pricing, though customer attendance at presentations and meetings was low. In addition, LIPA was unable to attract significant participation in the pilot TOU rates by commercial customers. LIPA believes this is a rate structure issue more than a lack of interest on the part of customers. However, LIPA has encountered issues with IHDs in both pilot areas, as well as low usage of the web-based tools.

The solicitation of residential TOU rates under Phase 2 was completed during Q2 2010 with an acceptance rate in excess of 50 percent. Presentations on Smart Grid, details of the Smart rate structure (i.e., TOU), and energy savings tips regarding electric appliance energy consumption were conducted for residential customers in both pilot areas (Hauppauge and Bethpage). Customers were instructed on how to shift usage from peak to off-peak periods and the potential cost savings. Previews and training of web tools and IHDs were also included. Attendance at these presentations was poor, despite the high interest in testing the TOU rate. All 117 residential customers were invited to attend, but only 15 customers actually did so.

The Phase 2 solicitation of commercial TOU rates commenced during Q3 2010 with only six customers choosing to participate out of 96 eligible. Sixty-two of the eligible commercial customers are small- to medium-sized businesses. The structure of the TOU rates used in the pilot (in particular, the definitions of peak and off-peak hours) may have made it difficult for these customers to gain savings. Efforts to enroll more commercial customers continued during Q4 2010 with the assistance of LIPA's Major Accounts organization. However, no additional commercial customers elected to participate.

Phase 2 also included providing both residential and commercial customers with web-based tools to better understand their own electricity consumption and usage patterns. In the Bethpage pilot area, a web-based tool from eMeter was provided to residential customers in January 2011, after a longer than anticipated design, build, and test process to bring the meter data from the Vendor A system through eMeter's Energy Engage system, and ultimately to the customer. Since the tool became available, the number of participants accessing the web tool increased from 13 at the end of Q1 2011 to 18 at the end of Q2 2011. Since then, the number has remained constant. A similar tool was made available to Bethpage commercial customers with meters that are actively communicating meter data to eMeter's

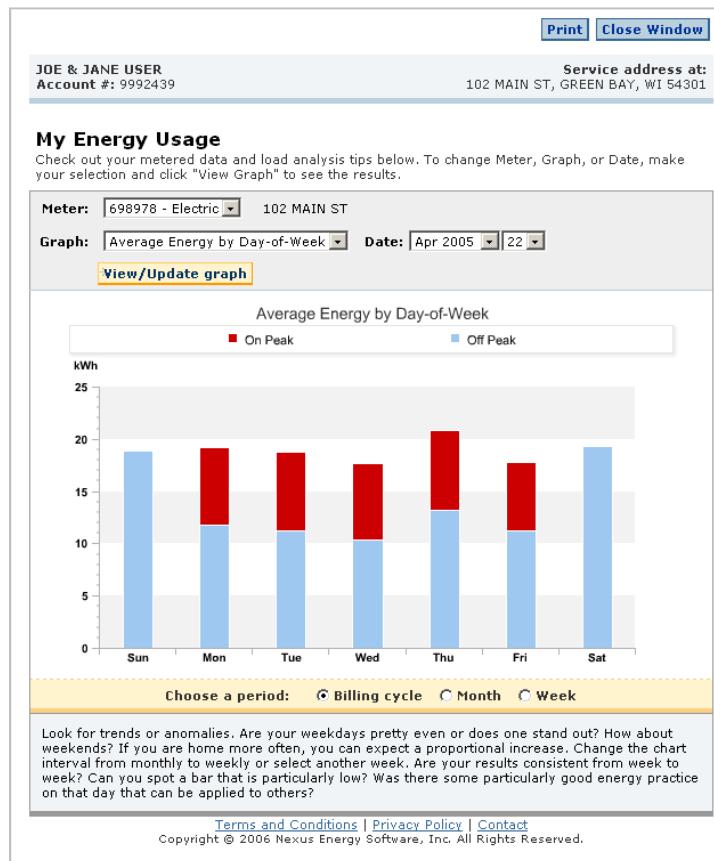
Energy Engage system in late October 2011. However, there has been no customer participation to date. The following figure shows an example of the Bethpage web tool display.

**Figure 3-10. Example of Bethpage Web Tool Display**



In the Hauppauge Pilot area, the Vendor B web tool was initially made available to residential customers in mid-April 2010. However, customer response to this tool was extremely poor with an average of only six customers utilizing the tool in 2010 and four in 2011. The tool was never made available to Hauppauge commercial customers because of Vendor B's problems with its commercial meters. The following figure shows an example of the Vendor B residential web tool display used in Hauppauge.

**Figure 3-11. Example of Vendor B Hauppauge Web Tool Display**



As previously discussed, the Vendor B system was replaced with Vendor C's AMI system in mid-2011. LIPA contracted with eMeter to build a similar web tool to that being used in Bethpage for Hauppauge. eMeter's Energy Engage was made available to both residential and commercial customers in the Hauppauge Pilot area in September 2011 and October 2011, respectively. Despite customer solicitation, on average only 11 residential (and no commercial) customers per month have accessed the website to retrieve meter consumption data.

The deployment of IHDs was also planned under Phase 2 of LIPA's marketing strategy. In Bethpage, Vendor A elected the third-party IHD to be used with its AMI system. The devices were delivered in June 2010 and lab testing commenced in July. This testing identified several issues related to programming firmware upgrades. These issues were addressed by Vendor A and the IHD supplier, and deployment of the units commenced in September 2010 to Bethpage residential participants. Four IHDs were deployed by the end of 2010. However, before the remainder of the units could be deployed, customers who already had the unit were identifying connectivity issues.

The IHD manufacturer ultimately notified Vendor A that it would no longer support or produce an IHD for the project. Vendor A replaced all of that supplier's IHDs with those of another manufacturer. Testing of these replacement devices was conducted in Q2 2011 in the lab environment, where connectivity and meter display issues were identified. Joint efforts by LIPA and Vendor A technical

personnel to resolve these issues commenced in Q2 2011 and continued into Q3 2011. During Q3, it was determined that additional AMI module firmware upgrades, adjustments of polling times to 60 seconds, and HAN certifications were necessary prior to IHD deployment. This process commenced at the end of Q3 2011 and was completed for all but three meters at the end of November 2011. Given the late stage of the pilot, IHD deployment did not proceed.

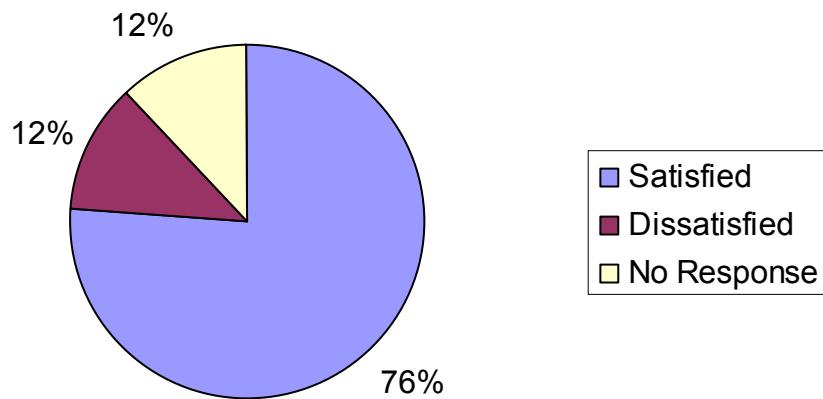
In Hauppauge, Vendor B's technical team finalized the development of the IHD manufactured by its chosen third-party supplier and shipped four units for testing in August 2010. These units failed to conform with specifications and replacement units were delivered and lab tested in Q4 2010. However, additional failures occurred and Vendor B did not expect to deliver working replacements until Q3 2011.

As noted earlier in this report, the Vendor B AMI system was replaced with Vendor C's AMI system due to Vendor B's inability to deliver fully functioning meters and IHDs to support this pilot in a timely manner. Vendor C offers IHDs from two suppliers. LIPA expects to deploy both types of IHDs. Lab testing of both units undertaken in the beginning of Q4 2011 indicated that AMI module and internal meter profile upgrades were required prior to deployment. Vendor C completed these upgrades in October 2011. Residential customers have been contacted and only 11 customers have requested units. Again, given the late stage of the pilot, deployment has not proceeded. LIPA expects to deploy IHDs in Hauppauge outside of this pilot, as part of the testing of such devices for the AMI portion of its Smart Grid Demonstration Project (DE-OE0000220).

As part of Phases 3 and 4, market research was conducted in Q1 2011 with Smart Pilot participants to determine satisfaction with the pilot and the tools available at the time and to understand energy consumption changes and demographics. A customer survey was conducted online and yielded a 43 percent response rate. Among those that responded, 96 percent stated they made changes in how and when they used their appliances, which dispelled the notion that most of the savings were attributed to "free riders." Satisfaction with the pilot among respondents was at 76 percent, while only 12 percent were dissatisfied. Those who reported dissatisfaction with the pilot were those that chose not to participate in the Smart TOU rate. Additionally, these customers did not have as much interaction with LIPA as those that were satisfied.

LIPA had originally planned to conduct additional surveys in Q1 2012. However, all project funds were previously expended and additional information from such surveys would not appear to materially add to the knowledge gained from the pilots.

**Figure 3-12. Customer Satisfaction with Pilot**



### **3.5.3. *Assessment of Problems and Impact on Project Results Relating to TOU Pricing***

Additional efforts aimed at commercial customers are necessary for greater participation in the TOU rate. The principal area of concern is whether the TOU rate offered provided appropriate incentives and opportunities to save on energy costs. LIPA is currently reviewing the structure of these rates to encourage greater participation in the future. Increased participation would enable a better assessment of commercial customer satisfaction as well as behavior changes with regard to energy consumption. Equipment delays, as well as delays encountered with developing and deploying web-based tools, also impacted customers' ability to monitor consumption. However, analyses of residential customer data indicated that participating residential TOU customers saved an average of \$157 per customer despite the delays. The average savings was 5.66 percent and 7 percent of the participating customers saved over 10 percent. See Figure 3-6 and Figure 3-7 in Section 3.2. It is anticipated that had the web tools and IHDs been available sooner, these savings could have been greater.

## **3.6. Project Activities, Approaches, and Problems Encountered Relating to Meter Data Management System Specification Development – SOPO Task 5**

**Task 5.0- Manage Meter Data:** *A Meter Data Management System shall be developed to manage the large volume of data expected from the meters as well as providing data verification. An IT Project Management and scoping team shall be assigned to perform the data investigation requirements and to review various MDM vendor and system capabilities. System requirements, a list of vendors shall, and an RFP document shall be prepared.*

A portion of the project scope included development of system requirements, identification of vendors, and preparation of an RFP document for a new MDM System that could support a full deployment of AMI. Because this was a major project involving IT, metering, and customer billing, LIPA formed a cross-functional project management and scoping team consisting of IT, Metering, and Marketing/Customer personnel, as well as a consultant with extensive AMI and MDM expertise. The project management team was charged with investigating the data requirements and reviewing various MDM vendor and system capabilities, leading to the preparation and issuance of a final RFP.

MDM requirements were completed in Q3 2010 and an RFP subsequently issued.

### ***3.6.1. Problems Encountered and Departure from Planned Methodology***

Because the project team was staffed with the appropriate disciplines and expertise, there were no significant problems encountered during the development process.

### ***3.6.2. Assessment of Problems and Impact on Project Results***

As noted above, there were no significant problems encountered during the development of the MDM RFP which was completed as planned in Q3 2010.

## **3.7. Other Lessons Learned**

LIPA captured a number of “lessons learned” that will prove valuable in connection with future deployments of meters and TOU pricing. Many of these are reflected in the previous sections of this report. Several additional items are noted below.

### ***3.7.1. Meter Deployment***

All three meter deployments utilized a manual paper tracking system that required the field technician to record various information including meter number, NIC card number, and other installation data. This manual process created errors in recording the data and complicated the data entry process. Modern installation and tracking systems are available to automate this process and create error-free, large-scale deployments.

Another issue that did not significantly impact the project but that has implications for future deployments was access to meter locations. Each of the customer sites chosen for the project was pre-inspected. At some locations, LIPA discovered conditions that would interfere with the installation of AMI meters, such as customer-installed fences, decks, railings, landscaping, etc. Since all locations were pre-inspected, any location with an interference was eliminated from the pilot sample set of customers. There was, however, one location in the Hauppauge area where the customer modified his deck within a couple of days allowing a meter change out (Vendor B to Vendor C) to take place. If LIPA elects to proceed with a full-scale system-wide deployment, interferences will have to be addressed.

## **3.8. Project Activities, Approaches, and Problems Encountered Relating to Project Management and Reporting – SOPO Task 1**

***Task 1.0- Develop Project Management Plan:*** *System configurations and requirements shall be prepared that define full meter functionality, communication networks, in-home devices, web portals and distribution automation opportunities. Related costs and legal issues shall be identified. A project management plan shall be prepared that captures these insights and shall be used to manage project schedule, costs, quality, and deliverables.*

### ***3.8.1. Project Activities and Approaches***

The project team prepared, revised as required, and executed a project management plan to ensure for the timely completion of project tasks. Weekly team meetings were held internally to review the previous week's accomplishments and setting action items for the following week's activities. Weekly meetings with vendors were also held and action item lists developed to identify installation and technical issues as part of the project tracking. Additionally, bi-weekly meetings with the LIPA management team were held. These meetings allow each team member and management lead to discuss and understand the issues and react accordingly to technical or construction issues.

### ***3.8.2. Problems Encountered and Departure from Planned Methodology***

Maintaining the project schedule was primarily impacted by vendor technical and equipment delivery issues. Despite weekly vendor meetings, vendors' scheduled commitments were frequently delayed or missed as major portions of the AMI technology being tested were still under development. Additionally, once equipment was developed or modified, acceptance testing both by the vendor and LIPA sometimes revealed numerous deficiencies, further delaying the project.

### ***3.8.3. Assessment of Problems and Impact on Project Results***

As noted above, despite LIPA's efforts to keep the project on schedule, continued vendor delays in providing resolutions to existing equipment issues or providing replacement equipment caused delays in evaluating vendor systems and equipment. Ultimately, however, working AMI solutions were deployed in both pilot areas.

## 4.0 Products Developed

No products were developed and no technology transfer activities occurred during the project.

## 5.0 Computer Modeling

The project did not involve computer modeling.