Commonwealth Edison Company's

AMI Assessment Customer Applications Plan

Attachment 4

May 30, 2009

ComEd®

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Project Goal

Between the June, 2010 and May, 2011 billing cycles, ComEd will have the opportunity to gather and study experimental and empirical evidence by conducting an AMI customer applications assessment. This assessment will attempt to determine the relative benefits of various combinations of rate, enabling technology, customer education, and customer experience. This, in turn, will allow ComEd to enhance the assessment of its AMI options. ComEd will seek the approval of the Commission to conduct this study and recover its costs.

- The study will include approximately 129,000 residential and non-residential AMI customers, plus approximately 5,000 customers outside the AMI footprint.
- Residential customers will be randomly assigned to 24 different combinations of control and experimental groups. Each group will have a different rate and/or enabling technology applications.
- Non-residential customers **will not** be randomly assigned to control and application groups. Instead, there will be one non-residential customer group. This group receives an AMI meter, remains on its existing rate, and receives AMI web and data services.
- Observation and measurement of energy behavior will occur over a one-year period, including all energy use seasons.

Assessment Variables

The AMI assessment for residential customers will be a randomized controlled field trial that compares the effects of Rate Type and Enabling Technology Type on the energy behaviors of customers (*Figure 1*). Appropriate customer education and customer experience will be embedded into each application cell.

Rate Type	Enabling Technology Type: None	Web	Web + IHD Basic	Web + IHD Advanced	Web + IHD + PCT
Flat Rate					
Increasing Block Rate					
CPP/DA-RTP Rate					
PTR/DA-RTP Rate					
DA-RTP Rate					
TOU Rate					

Figure 1: Simplified structure of the AMI assessment. Red cells indicate interactions that will not be tested.

Measurement and Validation

Customers recruited for the AMI assessment will come from the I-290 Corridor, City of Chicago and regions outside the AMI footprint in which customers have interval meters. ComEd will use an opt-out method for residential customer involvement and will randomly assign customers to application groups. To compare changes in consumption across the application groups, the M&V analysis will quantify the differences in hourly loads between those application groups using ANOVA and ANCOVA tests. Customer usage data and socio-demographic data will be used for these tests. Additionally, ComEd will conduct a process evaluation to quantify usage impacts using measures such as customer favorability, satisfaction, and involvement.

Project Plan

ComEd's project plan has five key objectives:

1. Design the AMI customer experience and customer education.
2. Select enabling technologies that offer the greatest value.
3. Secure necessary approval to use six types of rates on an experimental basis.
4. Test the impact of a wide spectrum of dynamic pricing options in conjunction with a wide range of enabling technologies on system peak demand, energy consumption and reliability.
5. Deliver the AMI Customer Applications Assessment evaluation report.

ComEd will conduct the AMI assessment between the June, 2010 and May, 2011 billing cycles. The overall budget for the AMI Customer Applications Assessment is $12,619,400.

Risks and Contingencies

The key risk categories for the project are threats to validity, project, customer experience, and technology. ComEd's strategy for mitigating risks centers on three key elements:

1. Processes. All efforts associated with this project are aligned with logical, systematic processes to execute the AMI assessment. A well-defined process reduces risk.
2. Models. Ideas and designs are derived from evidence-based research and models. Using models to guide design decisions reduces risk.
3. Standards. Alignment with various standards, from project management standards to research validity standards. Alignment with these standards reduces risk.

1. Introduction

This section of the plan revisits the regulatory decisions and stakeholder efforts that have shaped the AMI assessment, defines the scope of the AMI assessment, and describes the purpose and structure of this plan.

1.1 AMI Assessment Background

The Illinois Commerce Commission, in its final order in Docket No. 07-0566, authorized ComEd to deploy a "pilot program" of up to 200,000 advanced electricity meters and associated advanced metering infrastructure (AMI). The Commission also directed ComEd to participate in a stakeholder workshop process intended to, "develop project goals, timelines, evaluation criteria and Phase 0 technology selection criteria." (Order at 139). The Order neither specifically required, nor exluded, an examination of customer response enabled by the AMI deployment.

Early in the workshop process it became clear that parties did not believe that a complete assessment of the benefits and costs of an ultimate AMI deployment could be considered without examining potential changes in customer behavior that could result from pricing and technology options tied to the AMI system.[1] A key feature of an AMI deployment is that it provides much more granular energy use data, which when combined with pricing and technology options taking advantage of these data, can trigger changes in the level and shape of customer loads.

Two formal stakeholder workshops were held to explore customer-side issues. A number of separate brainstorming sessions were held with representatives of parties particularly interested in this issue in an effort to discuss various possible behind-the-meter elements of the initial AMI deployment. This collaboration produced the basic design for what we believe is one of the most comprehensive customer behavioral assessments conducted for any utility in the country. The purpose of this plan is to describe this design and ComEd's proposed process for its implementation. The structure of the residential assessment is made up of 24 specific experimental "applications," as we call the different combinations of rate designs, customer technology, and information and education being studied. ComEd has designed each application to test customer receptivity to a specific pricing and technology package, as well as estimate the likely change in the electricity demand and energy consumption resulting from customer adoption. ComEd will assign randomly selected and appropriately sized groups of residential customers to each application. The data concerning the resulting peak demand, load shape, and energy consumption will be used to support the benefit-cost analysis of the AMI deployment.

ComEd believes that the proposed assessment will establish Illinois as the leading state in developing a customer-centered research model of AMI and smart grid deployment:

- This will be the most comprehensive assessment of AMI-enabled behavioral response to-date, in terms of number of subjects, using a randomized controlled field trial (RCFT).
- This will be the first assessment to simultaneously test, through an RCFT, six different types of rates that nudge customers' energy efficiency, demand response, and load shifting behaviors.

[1] Feedback received during the AMI Workshop process demonstrated this interest. *See* ComEd AMI Workshop: 90-Day Report No. 1, Prepared for the Illinois Commerce Commission by R.W. Beck and Plexus Research, March 9, 2009.

- This will be the first assessment to simultaneously test, through an RCFT, four different types of enabling technology for customer feedback and demand response automation.
- This will be the first AMI assessment that tests, through an RCFT, the effects of free versus purchased enabling technology.
- This will be the first AMI assessment that tests, through an RCFT, the effects of customer education.
- This will be the first AMI assesment that assesses through action research how the customer experience impacts the adoption of the AMI system.

1.2 Scope of the AMI Assessment

The scope of the AMI assessment includes residential customers and non-residential customers. For residential customers, the scope includes approximately 129,000 customers in the AMI footprint and 5,000 customers outside the AMI footprint. Both non-electric space heating and electric space heating segments are included in this scope. ComEd will randomly assign residential customers to 24 experimental control and application groups

For non-residential customers, the scope includes approximately 10,000 customers within the AMI footprint. All of these customers will receive an AMI meter, will remain on their current rate, will be able to view their AMI data on ComEd's website, and will be able to download their AMI data to their own systems. The non-residential customer group is a single group that **will not** be assigned to experimental controls and applications.

1.3 Purpose and Structure of this Plan

Over a period of several months, ComEd met with a number of stakeholders to develop a structure for assessing the benefits of a variety of customer-side applications, where each application is represented by a combination of pricing, customer technology, customer education/communication, and customer experience options. The objectives supporting this structure identified by the group included the following:

- Test customer response to a variety of rate designs intended to modify the shape and magnitude of customer load.
- Test the impact of several on-premises devices on the shape and magnitude of customer load. These devices include those that provide real-time information on customer energy use and cost as well those designed to enable control of customer loads by the utility and customer.
- Understand customer receptivity to and patterns of use of these on-premises devices.
- Understand the likely uptake of the rate applications and technologies that could be expected under a broader deployment.
- Identify the combination(s) of pricing and technology options, as well as the methods of customer communication that create the most compelling customer-side offering(s) for an AMI deployment.
- Estimate the magnitude and value of changes in the shape and magnitude of customer loads as an input into the benefit-cost analysis of the AMI deployment

The purpose of this plan is to describe the structure of the assessment that has been designed to address these objectives, outline the processes proposed for implementation of the assessment

and propose a plan for the evaluation of the customer applications. The evaluation is intended to yield statistically valid estimates of customer behavioral response. In addition, it will provide insight into the receptiveness of customers to alternative pricing and technology packages in an effort to refine the customer experience associated with AMI. Finally, the evaluation will test the effectiveness of customer messaging and education with respect to AMI, pricing options and several types of on-premise technology for reporting and controlling energy use.

Section 2 of this plan describes in detail the structure and framework of the assessment for residential application groups. It includes the proposed rate and technology applications and the general sample design to be used to test these applications. Section 3 describes the evaluation requirements, specifically the measurement and validation (M&V) components of the AMI assessment for residential customers. These requirements include details about the key measures and methods associated with the assessment. Section 4 presents the project plan. The project plan includes the specific tasks, resource requirements, responsibilities, schedule, budget, and deliverables. This guides readers in assessing ComEd's approach and capabilities for executing the AMI assessment. A final section summarizes the key risks and contingencies associated with the AMI assessment. The appendix provides detailed information and elaboration about key elements of the plan.

2. Structure and Framework of the Assessment

This section of the plan proposes the structure and framework of the AMI assessment for residential customers. It describes the key *focus areas* (energy efficiency, demand response, and load shifting), *independent variables* (meter, rate, enabling technology, pricing, customer education, and customer experience), and *applications* that are part of the randomized controlled field test (RCFT).

2.1 Overview

The general structure of the proposed AMI assessment incorporates five steps:

1. Engage approximately 129,000 customers from the I-290 Corridor and parts of the city of Chicago. Additional customers outside of these regions (approximately 5,000) will participate in existing meter control and application groups.
2. Randomly assign residential customers to 24 different rate and enabling technology applications that include customer education and customer experience.
3. Assign non-residential customers to one group that receives AMI data access.
4. Observe and measure customers' energy behavior from the June, 2010 billing cycle to May, 2011 billing cycle. Customers will be assigned to the control and application cells for only one year, after which ComEd will place them back on otherwise applicable non-experimental rates unless the customer makes another choice.
5. Determine which combination of rate and enabling technology is most valuable, where value is defined as the combination of rate design, enabling technology, customer education, and customer experience that offers the greatest benefits for the least cost. ComEd will assess value from a variety of perspectives: societal, regulatory, utility, and customer.

Figure 2 shows a simplified structure of the assessment. Each cell in the table represents an application combining a specific rate and enabling technology (as well as customer education and customer experience). ComEd randomly assigns customers to each cell and collects energy behavior data for one year. At the end of one year, ComEd analyzes the data, compares the cells by testing for cross effects, and reports the results in an evaluation report.

Rate	Enabling Technology				
	None	Web	Web + IHD Basic	Web + IHD Advanced	Web + IHD + PCT
Flat Rate					
Increasing Block Rate					
CPP/DA-RTP Rate					
PTR/DA-RTP Rate					
DA-RTP Rate					
TOU Rate					

Figure 2: Simplified structure of the assessment. Red cells indicate interactions that will not be tested.

2.2 Focus Areas

The overall framework for the AMI assessment is organized around three **focus areas**:

- **Energy efficiency and conservation** – Customers permanently save energy through the installation of energy efficient equipment, or permanently alter their consumption behavior. Example: Replacing incandescent lights with compact fluorescent lamps (CFL), or setting thermostats higher in the summer.
- **Demand response** – Customers save energy during critical times by volunteering to temporarily reduce load when called upon. Example: Temporarily raise a thermostat to 78° or higher during peak hours of a summer day.
- **Load shifting** – Customers shift energy usage to different times of the day to take advantage of lower energy rates. Example: Doing laundry at 8:00 PM rather than 2:00 PM.

These three focus areas succinctly describe the primary desirable, measurable outcomes that ultimately benefit society, regulators, utilities, and customers. However, achieving each of these outcomes must start with a change in customer behavior. Customers must choose to install CFLs, raise their thermostat, and do laundry at different times. Thus, the three focus areas suggest a set of subordinate research questions:

- How does ComEd *nudge*[2] customers to invest in energy-saving equipment?
- How does ComEd *nudge* customers to conserve energy during peak periods?
- How does ComEd *nudge* customers to shift high-energy tasks to other times of the day?

While there are many ways ComEd can nudge customers, the framework ComEd is using to achieve this is called *customer performance.*[3] If ComEd wants customers to perform differently, in terms of energy efficiency, demand response, and load shifting, ComEd must create for customers an experience that orchestrates four primary variables: Vision, Access, Incentive, and Expertise (*Figure 3*). *Vision* describes the goals, expectations, and feedback integrated into an

[2] The principle of nudge is derived from the work of two University of Chicago professors, Richard Thaler and Cass Sunstein, and discussed in their 2008 book *Nudge*. It reflects the intersection with people's freedom of choice with encouraging them to do the right things.

[3] See Honebein, P.C. & Cammarano, R.F. (2005). *Creating Do-It-Yourself Customers*. Natorp, OH: Thomson Texere.

experience. *Access* reflects the environment of the experience and the tools provided to customers, such as an in-home display. *Incentive* is the motivator that drives the customer to perform in a certain way, whether that incentive is a reward or punishment. *Expertise* is the knowledge and skill customers acquire through specific customer education programs, like a product instruction manual.

Figure 3: Customer performance orchestrates four primary factors: Vision, Access, Incentive, and Expertise.

It is from this customer performance model and previous AMI assessments conducted by other utilities that ComEd derives the key independent variables for its AMI assessment. An independent variable is a factor that can be varied or manipulated in an experiment. *Table 1* provides an overview of the six independent variables, each of which will be described in greater detail later in this section.

Variable	Customer Performance Linkage	Usage in AMI Assessment	Description
Meter Type	Access	Primary Variable	The AMI assessment will include both existing meters (control) and smart meters.
Rate Type	Incentive	Primary Variable	Electricity rates that provides incentives or disincentives for certain customer behaviors.
Enabling Technology Type	Vision, Access	Primary Variable	Web site, in-home displays, and programmable communicating thermostats that provide customers information and feedback, or automatically control high-use appliances (i.e. HVAC).
Enabling Technology Acquisition	Access, Incentive	Secondary Variable	Policies providing customers enabling technology for free, or asking customers to purchase enabling technology.
Hold Harmless	Access, Expertise	Secondary Variable	Policy that reduces customer risk associated with high bill consequences, allowing customers to experiment, explore, and learn from their own trial and error experiences.
Customer Education	Expertise, Vision	Secondary Variable	Content, media, methods, and process for enhancing knowledge, skills and attitudes related to rates and enabling technology, as well as goals and tactics associated with energy efficiency, demand response, and load shifting.
Customer Experience	Access	Secondary Variable	Processes and procedures for installing smart meters, signing up customers for online access to data, notifying customers of demand response days, and so on.

Table 1: Key independent variables in the assessment.

2.3 Application Cells

ComEd developed 24 specific residential customer application cells to address the focus areas and independent variables outlined above. Each application cell represents the combination of a specific rate design and customer-side enabling technology. All applications include customer information and education keyed to the application being received. Six rate designs and four enabling technologies were considered:

- Rate Designs
  - Existing flat rate – for control purposes.
  - Customer-specific Increasing block rate (IBR) - to test energy conservation response of individual customers.
  - Critical peak price overlaid on a day-ahead real-time price (CPP/DA-RTP) - to test demand response.
  - Peak-time rebate overlaid on a day-ahead real-time price (PTR/DA-RTP) - to test demand response.
  - Day-ahead real-time price (DA-RTP) - to test load shifting response.
  - Time-of-use rate (TOU) - to test load shifting response.
- Enabling Technologies

- Web - presentment of hourly consumption and cost data to customers via a web page.
- Basic in-home display (Basic IHD) - a device capable of taking real-time consumption signals from the meter and displaying consumption and cost information.
- Advanced in-home display (Advanced IHD) - similar to the Basic IHD version with additional internet capabilities and advanced graphics.
- Programmable communicating thermostat (PCT) - a device that enables the utility to remotely control operation of a customer's thermostat with the ability for the customer to override the control. Also includes an IHD, which may be integrated into the PCT device.

Various combinations of these individual technologies and rate designs were assembled into the 24 applications (including controls), as illustrated in *Figure 4*.

		Enabling Technology Type				
		None	Web	Web + Basic IHD	Web + Advanced IHD	Web + PCT/IHD
Flat Rate Type N = 1,800	**Flat Rate Existing Meter No Education**	Control F1 N=200				
	Flat Rate Existing Meter Education	Application F2 N=200				
	Flat Rate AMI Meter Basic AMI Education	Control F3 N=200				
	Flat Rate AMI Meter Education	Application F4 N=200	Application F5 N=200	Application F6 N=400*	Application F7 N=400*	
Energy Efficiency Rate Type N = 1,000	**IBR Rate AMI Meter Education**		Application E1 N=200	Application E2 N=400*	Application E3 N=400*	
Demand Response Rate Type N = 2,800	**CPP/DA-RTP Rate AMI Meter Education**		Application D1 N=400^	Application D2 N=400*	Application D3 N=400*	Application D4 N=400*
	PTR/DA-RTP Rate AMI Meter Education		Application D5 N=200	Application D6 N=400*	Application D7 N=400*	Application D8 N=400*
Load Shifting Rate Type N = 2,000	**DA-RTP Rate AMI Meter Education**		Application L1 N=400^	Application L2 N=400*	Application L3 N=400*	
	TOU Rate AMI Meter Education		Application L4 N=200	Application L5 N=400*	Application L6 N=400*	
N = 8,000		N = 800	N = 1,600	N = 2,400	N = 2,400	N = 800

Primary Application | No Application

* IHD and PCT applications are bifurcated (spit in two) to include both free and purchase scenarios.
^ D1 and L1 applications are bifurcated (split in two) to test a hold harmless scenario.

Figure 4: The residential customer AMI assessment matrix.

As shown in *Figure 4*, the evaluation component of the assessment is a randomized controlled field trial (RCFT) that primarily varies rate type and enabling technology type and tests them against control groups. The first control group (F1) represents customers with no advanced meter, a flat rate, and no information or education regarding energy efficiency or demand response beyond ambient communication.[4] The second control group (F3) represents customers, with an advanced meter, which remain on the existing flat rate and receive only basic information regarding the meter installation.

The "N" shown in each cell represents the number of participants required to yield a statistically valid estimate of behavioral response for the given application.[5] In total, the assessment requires a total of 8,000 participants across the 24 applications. Given that ComEd's residential customer pool is approximately 134,000 customers (129,000 residential customer inside the AMI footprint and 5,000 residential customers outside the AMI footprint), and that ComEd will randomly assign each of those customers to either a control or application cell, ComEd can accommodate an opt-out rate of up to 90%, which is a conservative estimate based upon the experiences of other AMI assessments.

Green cells in *Figure 4* indicate control groups or application groups. Red cells indicate interactions that will not be tested for sake of efficiency, cost, and subject availability. They are excluded for one or more of the following reasons:

- The interaction is impractical (e.g., an existing meter does not enable web presentment).
- The interaction is inconsistent in terms of energy efficiency, demand response, and load shifting outcomes (e.g., flat rate and PCT).
- The interaction results are already well known from previous research.
- The interaction results can be inferred from other applications (e.g., if F2 and F3 are significantly different in terms of customer education effects, ComEd can infer that F4-F6 would have been different as well).

[4] Ambient communication is newspaper, radio, television, direct mail, web, and so on from ComEd or the marketplace.
[5] The sample size is based upon the following assumptions: Total population = 135,000; Confidence interval = 9.11; Confidence level = 99%.

In *Table 2*, ComEd's hypotheses can be visualized as follows:

Application Cell(s)	Hypothesis
E3	Hypothesis 1: An increasing block rate with enabling technology (web + Advanced IHD) will result in the greatest energy efficiency benefits.[6]
D4	Hypothesis 2: A CPP rate with enabling technology (web + PCT/IHD) will result in the greatest demand response benefits.[7]
L3	Hypothesis 3: A DA-RTP rate with enabling technology (web + Advanced IHD) will result in the greatest load shifting benefits.
D4	Hypothesis 4: Overall, a CPP rate with enabling technology (web + PCT/IHD) will result in the best combination of energy efficiency, demand response, and load shifting benefits.
F7, E3, D3, D7, L3, L6	Hypothesis 5: Customers who pay for enabling technology will achieve greater energy efficiency, demand response, and load shifting benefits.[8]

Table 2: Hypotheses for the AMI assessment.

2.4 Description of Proposed Independent Variables

The following sub-sections describe the proposed independent variables in the AMI assessment. These variables include meter type, rate type, enabling technology type, enabling technology acquisition, customer education/communication, and customer experience.

2.4.1 Meter Type Variables

The assessment will investigate the effect of two types of meters on customer performance.

- One type of meter will be an interval data meter currently used by ComEd for load analysis. Approximately 5,000 of these meters are deployed outside the AMI assessment region. Four hundred customers with these meters will be randomly assigned to the two existing meter control (F1) and application (F2) groups.
- The other type of meter will be an AMI meter. This meter will be installed at residences and businesses within the assessment regions. All customers in the AMI footprint will receive this meter.

2.4.2 Rate Type Variables

The assessment will investigate the effect of six different types of rates on customer performance. These rates, other than the flat rate (which ComEd already uses), reflect current best practice for rate design. For example, critical peak pricing (CPP) is used extensively for commercial customers in several states, and is implemented on an opt-in basis for residential customers in Florida and on a default basis with one California IOU. Peak-time rebate (PTR) has

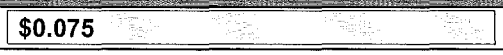
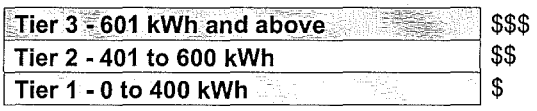
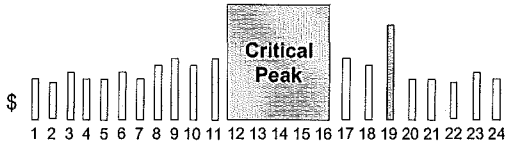
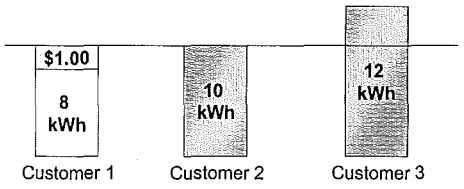
[6] See Faruqui, A. (2008), "Inclining toward efficiency," *Public Utilities Fortnightly*, August, 22-27.

[7] For hypotheses 2, 3, and 4, see Faruqui, A., Hledik, R., and Tsoukalis, J. (2009), "The Power of Dynamic Pricing," *The Electricity Journal*, 22(3), 42-56; Faruqui, A. and Sergici, S. (2009), "Household Response to Dynamic Pricing of Electricity – A Survey of the Experimental Evidence," *Brattle Group White Paper*; Faruqui,

[8] See Monroe, K.B. (1982), "The influence of price on product perceptions and product choice," *Advances in Consumer Research*, 9(1), 206-209; Martin, C.L. (1998), "Relationship Marketing: a high-involvement product attribute approach," *Journal of Product and Brand Management*, 7(1), 6-26.

been adopted by two California investor-owned utilities (IOUs). Time of use pricing has been adopted in Arizona and is being pilot tested in Connecticut.[9] The increasing block rate (IBR) is used extensively in California and contributes significantly to encouraging energy efficiency behaviors.

Table 3 provides an overview each of the rate type variables ComEd will use in the AMI assessment. Specific tariff details on these rate types may be found in experimental Rider AMP-CA.

Rate Type	Focus Area	Description	Example[10]
Flat	None	One single rate	
IBR	Energy Efficiency	An increasing block rate (IBR) structure increases the commodity price in relation to the customer's energy use. Tier 1 is the lowest cost, while Tier 3 is the highest cost.	
CPP/DA-RTP	Demand Response	A critical peak pricing (CPP) structure imposes a capacity charge on top of the real-time price during critical peak hours to motivate customers to conserve energy. ComEd proposes overlaying CPP on a modified day-ahead real-time pricing foundation.	
PTR/DA-RTP	Demand Response	A peak-time rebate (PTR) structure provides customers a monetary incentive to use less energy on a peak hours. To calculate the rebate, the customer's usage on the peak hours is compared to a reference level (which, for example, is derived from a customer's usage over the past five days). Customers earn a rebate for each kWh saved. Like CPP, ComEd proposes overlaying PTR on a day-ahead real-time pricing foundation.	

[9] See McCaffree, M (2009), "Utility-Scale Deployment of Smart Meters." Edison Foundation, Institute for Electric Efficiency.
[10] All examples shown in the table are illustrative.

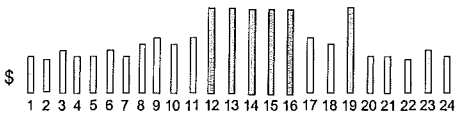
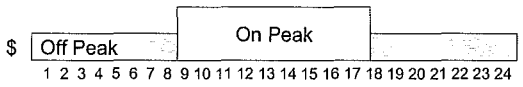
Rate Type	Focus Area	Description	Example[10]
DA-RTP	Load Shift	A day-ahead real-time pricing (DA-RTP)[11] structure encourages customers to shift their energy use to other times when energy costs are lower. Commodity prices change hourly over the course of the day. ComEd plans to use day-ahead prices from the PJM-administered energy markets.	
TOU	Load Shift	A time-of-use (TOU) structure also encourages customers to shift their energy use to other times. The commodity price is typically divided into two time-based segments, off-peak (lower price) and on-peak (higher price).	

Table 3: Rate type variables ComEd will use in the AMI assessment.

The charges developed in the rate designs shown in *Table 3* are variations from the electricity supply charges applicable under the existing tariff. The electricity supply charges under the existing tariff are distinguished by season, summer and nonsummer. They are also distinguished by customer group, customers without electric space heating and customers with electric space heating. Therefore, the charges developed in the rate designs shown in the previous table are variations from the following, as applicable:

- Customers without electric space heating:
  - Summer electricity supply charge.
  - Nonsummer electricity supply charge.
- Customers with electric space heating:
  - Summer electricity supply charge.
  - Nonsummer electricity supply charge.

2.4.3 Enabling Technology Type Variables

The AMI assessment will investigate the effect of four different types of enabling technology on customer performance. Three of the devices focus on providing feedback to customers regarding their energy use. One of the devices provides remote control of HVAC systems by the utility or customer during demand response events in addition to providing feedback.

[11] RTP is a new rate and is different from the RRTP rate. Customers on the RRTP rate in the assessment areas will be excluded from the AMI assessment.

A vast amount of evidence[12] suggests that feedback is critical for customer performance. In terms of providing customers feedback about their energy use, there are a variety of solutions that align themselves on the data, information, knowledge, and wisdom continuum. *Table 4* describes each of the enabling technologies ComEd will use in the AMI assessment.

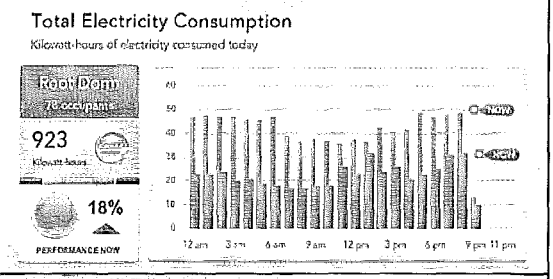
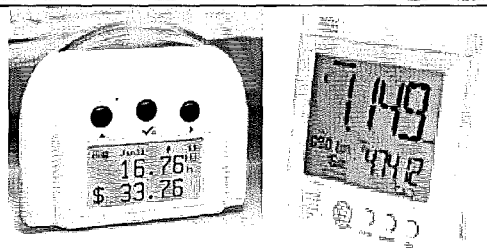
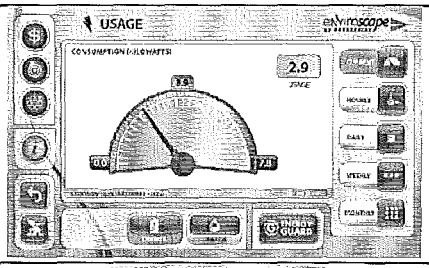
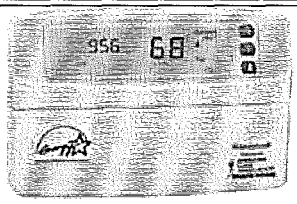
Enabling Technology	Description	Example[13]
Web	Displays energy usage data in graphical and textual form through a secure web browser. Typical features include time-based data viewing (hourly, daily, weekly, monthly, and yearly), varying units of measure (kWh, $, CO_2), and comparisons (e.g., previous month, previous year, similar residences).	
Basic IHD	A basic in-home display (Basic IHD) is a small device, typically battery-powered, that displays real-time energy usage data in various units of measure (kWh, $, CO_2). A common feature is price notifications, typically colored lights that indicate off-peak, peak, and critical peak prices.	
Advanced IHD	An advanced in-home display (Advanced IHD) is similar in function to a Basic IHD. However it provides advanced features and capabilities. It offers an internet connection for pricing updates, as well color, graphical displays that present a variety of information.	
PCT/IHD	A programmable, communicating thermostat (PCT) automates HVAC equipment. Customers can program the PCT to heat and cool at certain times of the day. The PCT can also receive signals from the utility or customer to raise or lower temperature during demand response events. ComEd expects that this may be an integrated device including both PCT and IHD functionality.	

Table 4: Enabling technology variables ComEd will use in the AMI assessment.

[12] See Honebein, P.C. & Cammarano, R.F. (2005). *Creating Do-It-Yourself Customers*. Natorp, OH: Thomson Texere; Darby .S (2006), "The effectiveness of feedback on energy consumption." A review for DEFRA of the literature on metering, billing and direct displays. Environmental Change Institute, University of Oxford.

[13] Enabling technology examples shown in this table are for illustration purposes only. No endorsement implied.

2.4.4 Enabling Technology Acquisition Variables

The AMI assessment will investigate the effect of two enabling technology acquisition scenarios: free and purchase. Whether the method of acquisition has a significant impact on energy-using behavior is an important question that has not yet been fully answered by other AMI assessments. In most AMI assessments, customers receive device-based enabling technology for free, whether it is an IHD (numeric display or Energy Orb[14]) or a PCT (web-based technologies are always offered for free).[15] Yet, to provide device-based enabling technology for free to all customers in a full-scale AMI implementation would be extremely expensive.

For this variable, ComEd will test two scenarios for the acquisition of the basic IHD, advanced IHD, and PCT.

- **Free**. Randomly selected customers will receive enabling technology for free, according to these conditions:
  - Basic IHD customers will receive the IHD in the mail following installation of the smart meter. The basic IHD is customer-installable.
  - Advanced IHD customers will be notified that they can receive a free advanced IHD, but must respond by web or telephone and schedule an appointment to have it professionally installed.
  - PCT customers will be notified that they can receive a free PCT, but must respond by web or telephone and schedule an appointment to have it professionally installed.
- **Purchase**. Randomly selected customers will receive multiple offers (mail, door hanger, web) to purchase (not rent) enabling technology at a subsidized price (with money-back guarantee). The cost of the enabling technology may be included on their monthly bill in a series of interest-free installment payments. If a customer purchases the enabling technology:
  - Basic IHD customers will receive the IHD in the mail. The basic IHD is customer-installable.
  - Advanced IHD customers must schedule an appointment to have the IHD professionally installed.
  - PCT customers must schedule an appointment to have the PCT professionally installed.

2.4.5 Hold Harmless Variable

The AMI assessment will investigate the effect of a hold harmless variable. Hold harmless means that customers will receive a credit on their bill if the total amount of their bill associated with the experimental rate exceeds the total amount of their bill if they had been on the flat rate. D1 and L1 are the only applications that will test the hold harmless variable.

[14] An Energy Orb is a glowing globe that changes color based on the price of energy. See http://www.ambientdevices.com/cat/orb/orborder.html.

[15] ComEd has found only one AMI pilot that investigated acquisition – Massachusetts Power Cost Monitoring Pilot Program. However, this pilot did not use randomized controlled applications to investigate this question.

2.4.6 Customer Education and Communication Variables

The AMI assessment will investigate the effect education and communication (collectively called "customer education") has on customer performance, another important effect that has not been directly tested in previous AMI assessments. While all AMI assessments have included customer education, ComEd has found none that compared the effectiveness of customer education versus no customer education on energy efficiency, demand response, and load shift behaviors.

Our approach to customer education is that it is a process, not an event. We cannot expect that customers will learn all they need to learn through one educational event. Nor can we expect that customers will take the time to participate in classroom-based training. Thus, our customer education will be:

- Delivered throughout the assessment.
- Distributed through self-instructional methods.
- As tailored as possible to the customer's needs, using:
  - Traditional methods, such as printed workbooks, user manuals, web site, web-based training, and in-bound call center.
  - Non-traditional methods, such as customer bills, email notifications, third-party partners and coalitions such as the Citizen's Utility Board (CUB) and community organizations, and social media (discussion boards).

All of these education methods will be held constant for all customers in the AMI assessment, except those in control applications (who will not receive extensive customer education). However, the content communicated by these educational methods will vary slightly based upon the application to which a customer is randomly assigned. *Table 5* describes the six primary content areas and the rules for who will receive that content:

Content Area	Description	Who Receives
AMI Assessment (PI)	This involves content related to the AMI customer applications assessment that is released through public information channels. Special care must be taken with this content so as to avoid threats to validity (see the Risks and Contingencies section).	All customers.
Smart Meter (SM)	This involves content related to the smart meter, in terms of what it is, how it works, how to read it, and so on. This content is coded as SM.	All customers receiving an AMI meter.
Purpose (PP)	This involves content related to the AMI investment and the desired outcomes, from both a customer perspective (save money, reduce waste) and an operational perspective (reduce costs, improve service). Also addresses energy efficiency, demand response, and load shifting principles. This content is coded as PP.	All customers assigned to application groups.

Content Area	Description	Who Receives
Tactics (TT)	This involves content describing how to reduce energy waste (energy efficiency), participate in demand response (including signing-up for demand response notifications), and shift energy usage to different times of the day (load shifting). This content will integrate the principles of goal-setting, which is a critical part of the customer performance model for establishing Vision. This content is coded as TT.	All customers assigned to application groups.
Rates	This involves content that explains how a specific kind of rate works. Content will be developed for all six rates and coded as follows: • FR = Flat Rate • IBR = Increasing Block Rate • CPP = CPP/DA-RTP Rate • PTR = PTR/DA-RTP Rate • DA-RTP = Real-time Price Rate • TOU = Time-of-Use Rate	Customers will only receive education for the rate associated with the application group to which they are assigned.
Enabling Technology	This involves content that explains how to use a specific kind of enabling technology. It will include custom content that ComEd designs, as well as the user manuals and online tools provided by vendors. Content will be developed for all four enabling technologies and be coded as follows: • Web = Web Only • BIHD = Basic IHD and Web • AIHD = Advanced IHD and Web • PCT = PCT, IHD, and Web	Customers will only receive education for the enabling technology associated with the application group to which they are assigned.

Table 5: The six customer education content areas in the AMI assessment.

ComEd will organize this content into 23 Smart Meter User Manuals versions (Cell F1 does not get any education). Each version will contain only the content that reflects the specific control or application, as illustrated in *Table 6*. Any other customer education materials provided to customers (e.g. web training) must align with the Smart Meter User Manual created for that control or application.

Cell	PI	SM	PP	TT	FR	IBR	CPP	PTR	RTP	TOU	WEB	BIHD	AIHD	PCT
F1	X													
F2	X		X	X	X									
F3	X	X												
F4	X	X	X	X	X									
F5	X	X	X	X	X						X			
F6	X	X	X	X	X							X		
F7	X	X	X	X	X								X	
E1	X	X	X	X		X					X			
E2	X	X	X	X		X						X		
E3	X	X	X	X		X							X	
D1	X	X	X	X			X				X			
D2	X	X	X	X			X					X		
D3	X	X	X	X			X						X	
D4	X	X	X	X			X							X
D5	X	X	X	X				X			X			
D6	X	X	X	X				X				X		
D7	X	X	X	X				X					X	
D8	X	X	X	X				X						X
L1	X	X	X	X					X		X			
L2	X	X	X	X					X			X		
L3	X	X	X	X					X				X	
L4	X	X	X	X						X	X			
L5	X	X	X	X						X		X		
L6	X	X	X	X						X			X	

Table 6: Matrix of the customer education associated with each application.

2.4.7 Customer Experience Variables

The AMI assessment will investigate the effect customer experience has on customer performance. ComEd defines customer experience as a collection of transactional touchpoints with which customers will need to interact to receive AMI services. Like customer education, customer experience variables will be created using established customer-centered design methods and standards,[16] and held as constant as possible for all control and application groups. The intention is to mitigate validity risks.

Table 7 describes the specific customer experience attributes that will need to be addressed for the AMI assessment. Some of these attributes are new, while others already exist at ComEd. The challenge will be to establish systems and processes so that, for example, customers assigned to the basic IHD applications are kept blind from advanced IHD applications, and that customers calling the call center will receive information and education associated with the application group to which they are assigned.

[16] Customer-centered design, also known as user-centered design, is a design philosophy and process that focuses on the needs, wants, and limitations of end users. For an overview, see http://en.wikipedia.org/wiki/User-centered_design.

Experience Attribute	Description	Who Receives
Service Script	A service script is a script/process map that documents the process of how a customer will complete a transaction. It is used by employees to deliver consistent service to customers and forms the foundation for employee training. Service scripts may vary slightly depending on the application. The core service scripts include: • Install smart meter • Sign up for access to web data • Sign up for notifications[17] • Receive basic IHD • Order advanced IHD • Order PCT • Install advanced IHD • Install PCT • Contact the call center for assistance (phone, email, web) • Opt out of the AMI assessment • Sign up for an energy efficiency program	Customers will only experience the service script for the transactions associated with the application group to which they are assigned.
Touchpoint	A touchpoint is a point of interaction where customer and ComEd communicate. The touchpoints that may vary slightly depending on the application include: • Call center • Web site • Direct mail (bill, promotions, etc.) • Field service • Market research • Employees who live in the AMI assessment geography	All customers may interact with any touchpoint. However, certain touchpoints may provide different interactions, based upon the application group to which the customer is assigned.

Table 7: Customer experience attributes included in the AMI assessment.

While our design of service scripts and touchpoints will be based upon generally accepted customer-centric design methods, which includes user requirements and focus group testing, there is a significant risk that a script or touchpoint may not deliver the impact ComEd desires when deployed to real customers. For example, ComEd might find the offer designed for customers to purchase an IHD has very low response rates. ComEd wants the ability to modify that offer to increase response rates. Thus, ComEd intends to use action research methods[18] to test, evaluate, and modify scripts and touchpoints as actual customers participating in the AMI assessment interact and respond to these experiences. While ComEd does not expect that these changes will have significant impact on the primary evaluation measures, ComEd will be able to assess impact by uniquely versioning scripts and touchpoints, and capturing the version experienced by customers.

[17] ComEd is obligated to notify customers for real or simulated demand response events associated with demand response applications, and has the intention of notifying customers in other applications as well.

[18] Action research is a methodology whereby solutions are put into actual service with actual customers on a large scale. Data is collected to determine whether the solution works (single-loop learning) and designers are free to reconsider their design approach if the solution doesn't work (double-loop learning), make changes, and redeploy an improved solution. See http://en.wikipedia.org/wiki/Action_research for additional information.

2.4.8 Detailed Description of Application Cells

A detailed description of the integration of these independent variables in each of the application cells may be found in Appendix A.

2.5 The Subject's Experience

To get a better sense of what the AMI Customer Applications Assessment feels like, the following hypothetical narrative in *Table 8* provides a vision of the assessment through the eyes of the customer. In it, you can get a sense of how the evaluation applications will be perceived by customers and the process-oriented nature of the educational applications. The following story depicts the experiences associated with application cell D2, which investigates the interaction between the CPP rate and a basic in-home display (IHD).

	Hypothetical Customer Experience
Step 1 Initial Notification	Duncan Grothe just got home from work and was going through the day's mail. "Junk, junk, junk, bill, bill, check, junk," Duncan muttered to himself until he stopped a piece of ordinary looking mail with the return address of ComEd. In big, bold letters on the envelope were the words, "IMPORANT INFORMATION ABOUT ELECTRIC RATE CHANGE." "Swell," said Duncan as he opened the envelope. He took out the first page and began to read. He quickly discerned from the page that 1) The state of Illinois, in connection with National and Illinois energy policy, was going to assess a new technology to provide customers more information about their energy use; 2) That Duncan was part of a group of specially-selected citizens to be part of this assessment; 3) That his home would get a new electric meter, a smart meter, in one month; 4) That his rate would change on May 1, 2010 from the flat rate he'd been paying for years to something called Critical Peak Pricing that promised him the opportunity to save money through wise energy use; 5) No more meter readers would be coming to his house three months after installation; and 6) That if he'd prefer not to participate in the assessment, he could opt-out by calling a special 800-number. "Hmm," thought Duncan, "Perhaps this is something that would help the kids remember to turn off the darn lights."
Step 2 Complete Pre-Install Survey	Duncan decided not to opt-out of the assessment and filled out the short survey that came with the notification letter (completing the survey offered a $15 bill credit, which Duncan thought was great). While he noticed that he could have completed this survey on-line, filling out the paper version seemed easiest for him.
Step 3 AMI Installation	Field technicians from ComEd came to his home and replaced his old mechanical electric meter with a new digital smart meter. Nobody was at home during the installation, but Duncan knew something had changed because of the door hanger tag informing him of the installation and the numerous clocks around the house that needed to be reset because of the outage. Curious, Duncan went to go look at the new meter and noticed that it had a digital readout rather than the spinning wheel and dials. From the information on the door hanger, Duncan found that he could easily read the meter data being displayed: Date – kWh – Time – kWh – and so on.

Step 4 Learning About Enabling Technology, Rates, and so on	Near the end of April, 2010, Duncan received in the mail a small box containing a quick installation poster (like you get with a computer these days), a Smart Meter User Manual, and something called an in-home display (IHD). Ignoring the poster and user manual, Duncan turned on the IHD. The IHD immediately indicated that it was connecting to his home's smart meter and a few seconds later it displayed his home's current hourly cost of electricity and kWh. Duncan went around the house shutting off lights and other electrical devices, and chuckled when the IHD indicated that the cost and kWh were lower than before. "How cool," thought Duncan. After Duncan finished playing with the IHD he returned his attention to the installation poster and user manual. The poster showed how to operate the IHD (which Duncan figured out on his own – it wasn't that hard), as well as provided instructions for accessing something called Online Energy Feedback. Duncan went to his computer, pointed his browser at the URL provided on the poster, and began the sign-up process for My Account. During the sign-up process, he learned about his new CPP rate and was able to sign up he and his family for day-ahead notification for something called demand response (which, as he learned, was a time period when electric rates were really high). After the sign-up process was complete, he clicked a link to view his home's energy information and was able to see his home's data from the time the smart meter was installed.
Step 5 The first month	Over the next month, Duncan and his family experimented with the IHD and learned what appliances and electrical devices had the biggest impact on costs. But toward the end of the month, the family's interest in the IHD waned, since they seemed to have figured out what's what in their home. But when Duncan's monthly bill arrived, he was disappointed to see that his bill was more than the previous month, and more than the same month last year. However, the amount was still less than the $15 credit he got for completing the survey. And, there was an insert in the bill that provided an explanation of why there might have been an increase, offered some tips for how to better control costs, and explained once again how the CPP rate worked. During the next month, Duncan and his family tried some of the suggestions, such as setting a goal for the amount they wanted to reduce, and were able reduce their bill 5% compared to the same month last year. They found that the Online Energy Presentment tool was very helpful for this, since it summarized the data and showed it in connection with the goal they set.
Step 5 The fourth month	During the fourth month, Duncan and his family received a day-ahead email notification that the next day was a demand response day, and that they should turn their thermostat up to 78-degrees, turn off lights, and avoid using appliances between 12 PM and 4 PM. The family implemented the suggestions. The day after the demand response day, Duncan received another email notification that their efforts helped avoid $5 in critical peak charges. At the end of the fourth month, the family's bill showed a reduction of 8% compared to the same month last year.
Step 6 End of the assessment	In April/May, 2011, Duncan received a survey from ComEd asking him about his experiences with the smart meter system. Completing the survey would earn Duncan a $35 bill credit, so he promptly completed the survey. A month later, Duncan received a letter from ComEd announcing that the AMI assessment was ending. The letter provided information that indicated over the past year Duncan saved on average 8.5%, which accounted for $127.50 in savings over the year. It also indicated that other people on the CPP rate saved an average of 7.3%, and out of all the different rates that were compared during the assessment, CPP was the best, in terms of not only customer savings benefits, but helping ComEd meet its energy efficiency and demand response goals. The letter also said that since the rates were experimental, Duncan would be returned to his flat rate until such time the Illinois Commerce Commission approved one or more of the tested rates for all customers.

Table 8: Hypothetical customer experience.

3. Proposed Assessment

ComEd's evaluation approach begins by asking questions and hypothesizing the answers to those questions. The questions and hypotheses driving the AMI assessment include the following:

- What mixture of rates, meter, enabling technology, and customer education support customer performance in achieving energy efficiency, demand response, and load shifting benefits?
  - Hypothesis 1: Customer-specific increasing block rates with enabling technology (web + Advanced IHD) will result in the greatest energy efficiency benefits.
  - Hypothesis 2: A CPP/DA-RTP rate with enabling technology (web PCT/IHD) will result in the greatest demand response benefits.
  - Hypothesis 3: A DA-RTP rate with enabling technology (web + Advanced IHD) will result in the greatest load shifting benefits.
  - Hypothesis 4: Overall, a CPP/DA-RTP rate with enabling technology (web + PCT/IHD) will result in the best combination of energy efficiency, demand response, and load shifting benefits.
- What are the customer performance differences between customers who receive enabling technology for free and those who pay for enabling technology?
  - Hypothesis 5: Customers who pay for enabling technology will achieve greater energy efficiency, demand response, and load shifting benefits.

This section describes the methodology for answering these questions by describing the primary regions included in the assessment, how ComEd will involve customers in the assessment, and the measurement and evaluation plan for the data ComEd will collect.

3.1 Regions Included in the Assessment

ComEd selected the I-290 Corridor and the city of Chicago as the two regions that will participate in the AMI assessment (Figure 5, *Figure 6*). While there may be other regions receiving AMI meters, such as the Community Energy Challenge winner and customers in Tinley Park (for AMI water meter testing), we do not expect to include these customers in the AMI customer applications assessment. Additionally, we will include customers outside these regions for experimental control. As shown in *Table 9*, these regions represent about 129,000 customers receiving AMI meters.

Location	Objective	Meters
I-290 Corridor Bellwood, Berwyn, Broadview, Forest Park, Hillside, Maywood, Melrose Park, Oak Park, River Forest	• AMI meter installation • Operating business case • Customer experiments	100,000
City of Chicago (exact location TBD)	• AMI meter installation • AMI technology technical limits testing • Expanded customer experiments	29,000
Existing meter customers outside the above locations.	• Experimental control • Customer education effects	5,000

Table 9: Characteristics of the AMI assessment locations.

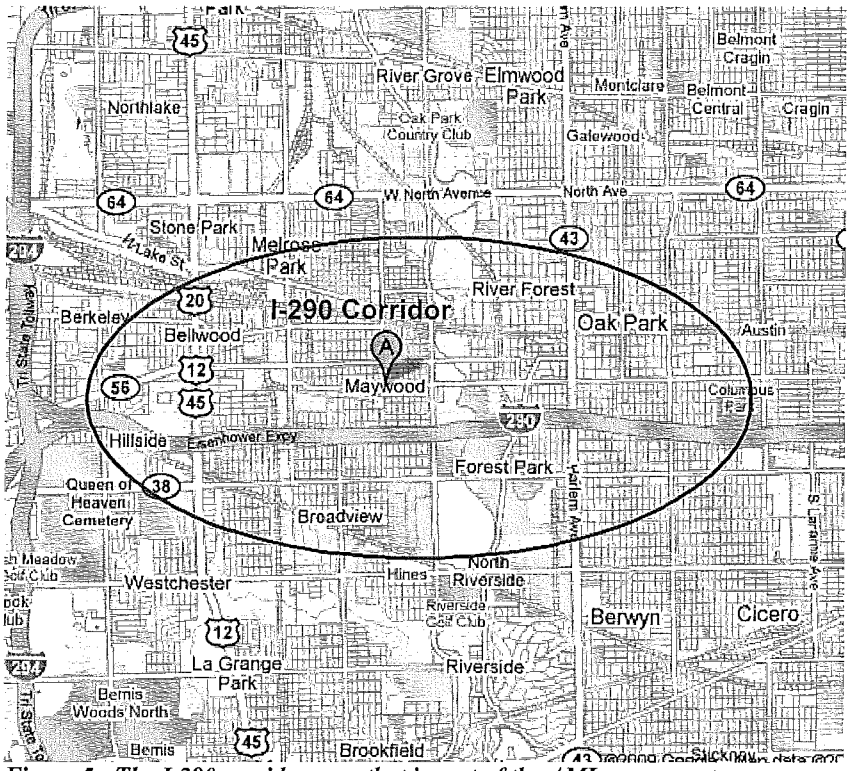


Figure 5: The I-290 corridor area that is part of the AMI assessment.

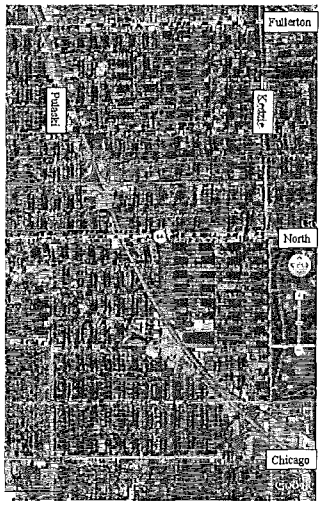


Figure 6: The city of Chicago area that is part of the AMI assessment.

ComEd has the best confidence with the I-290 Corridor producing results that can be projected across all ComEd customers as part of the operational business case. First, the I-290 Corridor offers the best location to validate the operational business case. Several operational metrics were used to establish rankings throughout the ComEd territory and the I-290 Corridor matches the system average more closely than other locations. Secondly, from a demographic perspective, the I-290 Corridor matches the system average very closely. The I-290 Corridor also

has a significant degree of variation within the area, so the demographic and the operational characteristics both cover a broad spectrum. Finally, the I-290 Corridor provides several transmission and distribution learning opportunities that will help assess the benefits and impacts for the future development of a smart grid system in the ComEd territory.

Chicago represents a large component of the ComEd customer base, which drives a good deal of operational and demographic characteristics for our territory. It also includes some unique physical environments (e.g., concentration of high rise buildings) which enables ComEd to better test the AMI technology's performance capabilities Also, Chicago offers some learning opportunities for the customer pricing program component of the pilot, which will help ComEd assess the overall acceptance of these programs across the ComEd customer base.

3.2 Customer Involvement Methodology – Opt-Out

As mentioned elsewhere in this document, the AMI assessment targets 129,000 customers, as well as 5,000 customers outside the AMI footprint. However, ComEd must have a least 8,000 residential customers who will fully participate in the assessment to ensure statistically significant results. "Fully participate" means that customers complete the pre-assessment survey, the post-assessment survey, and do not opt-out during the assessment.

The method we are using to involve customers is **opt-out**. In an opt-out method, customers in the AMI assessment are randomly assigned to a control or application group and receive the applications that are associated with that group. Thus, if a customer is assigned to application D2 (CPP + Basic IHD), the customer will receive an AMI assessment notification consistent with that application, be put on the CPP rate, and receive a basic IHD.

If a customer does not want to participate in the AMI assessment after receiving notification and the applications, the customer may call a special ComEd number to opt-out. Opt-out means that the customer:

- **Will** receive an AMI meter (which is required for the technology tests).
- **Will** stay on their current rate (flat rate for residential).
- **Will** be able to view their usage data on ComEd's website.
- **Will not** receive any applications associated with the group to which the customer is assigned.
- **Will** retain any applications previously provided.
- **Will** be able to request removal of any applications previously installed.
- **Will not** be contacted for any further surveys associated with the AMI assessment.

ComEd selected the opt-out methodology to enhance the realism and generalizability of the AMI assessment. Additional reasons for selecting the opt-out methodology are:

- Opt-out is a barrier which requires customers to take action. We expect that the number of customers who take action to opt-out will be significantly less than the 1-in-10 who agree to participate in opt-in.[19] This reduces customer recruitment costs.

[19] Faruqui, Ahmad (2009). Personal communications, April 10, 2009. Metrics indicate that it takes 10 customer contacts to find one customer who is willing to opt-in.

- Opt-out allows ComEd to assess customer complaining behavior and test retention and recovery strategies.[20] In other words, opt-out allows ComEd to collect data about customers who want to opt-out, and tests educational methods to retain those customers in the assessment.

In summary, ComEd believes that the opt-out method will provide greater insights into customer behavior, better overall results, and stronger generalizability for the future full implementation of AMI in the state of Illinois.

3.2.1 Opt-Out Method

ComEd designed the opt-out method to achieve three specific objectives: realism, random assignment of customers, and budget protection. The AMI assessment budget assumes that the number of customers fully participating is less than 12,000.

The opt-out method for customer involvement has the following steps:

1. Randomly assign 129,000 residential AMI customers to 34 control and application groups and 5,000 non-AMI customers to two control and application groups (24 control and application groups plus 12 bifurcated cells = 36 total groups). The result is an average of 3,472 customers assigned to each group (F1 and F2 will be less). Each customer in each group will be randomly assigned a unique number to indicate their selection position in that group (e.g., 1 through 3,472).[21]
2. Select the first 300[22] customers (1 to 300) from each control and application group and send them the AMI assessment notification with pre-survey. Determine 1) customer opt-out response, and 2) completion of pre-surveys. If opt-out number is less than 200 and pre-survey completion is less than a desired number[23], then repeat the AMI assessment notification process with the next group of customers (301 to N - number to-be-determined based upon response rate of previous notification) until the number of customers in each group is greater than 200 but no more than 333 (12,000 customers total).
    a. Customers completing the pre-survey will receive $15.
    b. Customer not completing the pre-survey will remain in the applications group.
    c. Customers may opt-out of the AMI assessment at any time and must contact ComEd by phone to formally opt-out.
        i. ComEd will attempt to retain these customers, if not switching to a retail electric supplier (RES), by providing additional customer education that is consistent with the application group to which the customer is assigned. Conversations with these customers will be recorded for further data analysis (assumes ComEd has a call recording policy for customer service

[20] In this context, retention and recovery is associated with participation in the AMI assessment only. Customer interactions involving discussions of other energy suppliers will follow existing ICC rules.
[21] This random assignment method may be enhanced to include a stratified sample based upon geographic or equipment characteristics (e.g. central HVAC).
[22] Assumes an opt-out rate of 33%.
[23] To be determined. ComEd's experience with non-incentive survey participation ranges from 12% to 15% for mail surveys, and 40% for phone surveys. Given the experience of other utilities, we estimate an incentive-driven survey having a response rate of 70% or higher.

improvement). Customers who are retained will be indicated as such in their customer record.

ii. There is no consequence for customers to opt-out. Customers opting out prior to the start of the rate application are kept on their current rate and are informed that none of their data will be used as part of the AMI application assessment.

iii. Customers may opt back in after they have opted out by contacting ComEd by phone prior to the start of the rate application. Re-opting in is permitted only if the number of total customers participating in the AMI assessment is less than the total number budgeted.

d. Customer may choose to acquire and use or not acquire or not use any of the enabling technology that is offered to them as part of their applications group, whether that enabling technology is free or available for purchase. ComEd will have measures to assess customer uptake of these offers, but customer decision not to acquire or use any of these resources does not constitute an "opt out". For purposes of the assessment, these customers are still are a participant in the group to which they were assigned. ComEd will include "involvement" measures as a means of segmenting and further understanding how adoption/use of enabling technology influences behavior change.

i. The A-IHD and PCT (free) applications must have 200 customers who agree to have the enabling technology professionally installed.

ii. Unless determined to be a potential confounding variable, ComEd will give customers not assigned to any control or application group access to the ComEd's website so they can view their AMI data online.

3.3 Measurement and Validation

The success of the AMI Assessment will depend on whether it produces statistically significant findings regarding changes in the behavior of the application groups, both relative to other application groups and relative to the control group. Specifically, the purpose of the measurement and validation (M&V) phase of the assessment is to quantify the extent to which customers change their electricity consumption patterns when they are exposed to new prices, provided with new information, and equipped with new technologies. For some application groups, this can be achieved through estimation of customer price elasticity. In other cases, it is achieved through methods such as Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA). These approaches to the M&V phase of the assessment are described in the following sections.

3.3.1 Measuring Changes in Consumption

To compare changes in consumption across the application groups, the M&V analysis will quantify the differences in hourly loads between those application groups. This approach is referred to as an ANOVA test. This type of comparison is useful, for example, in determining whether there is a conservation effect when customers are equipped with an IHD.

In this example, to conduct the ANOVA test, one would compare the average hourly loads of the two application groups (one with IHDs and the other without). If the two averages are statistically distinguishable from each other, then it can be concluded that equipping customers

with IHDs does in fact result in a change in consumption behavior.[24] If it is found that the means are too similar in statistical terms, then the results would not suggest that IHDs influence customer behavior.

ANCOVA is a more sophisticated method of ANOVA. Beyond simply comparing differences in average load, ANCOVA also allows for the control of key socio-demographic variables. For instance, in the previous example it could be the case that socio-demographic differences between two application groups are leading to differences in their load shapes. One application group might have a higher overall level of education than the other application group to which it is being compared. In that case, to the extent that education significantly influences electricity consumption, then the difference in load shapes might be inaccurately attributed to IHDs using the ANOVA test. Controlling for key socio-demographic variables allows for the effect of the application to be isolated.

These tests would also be valuable in assessing the effect of assessment-specific education on customer behavior. As described previously, participants in certain application and control groups will be educated about ways in which they can conserve energy, reduce peak demand, and shift usage from peak periods to off-peak periods. The educational effort will also provide information about AMI and the principles of goal setting. This will happen on an ongoing basis throughout the course of the assessment, so by measuring the change in customer consumption patterns at various points in the assessment, it will be possible to quantify the impact of these educational efforts as well as the rate at which learning took place.

Ultimately, both ANOVA and ANCOVA tests would likely be utilized in the M&V phase of the AMI assessment to characterize differences in consumption across the application groups.

3.3.2 Measuring Response to Prices

When the assessment program involves a change in the rate structure, then it is possible to employ a more sophisticated approach (compared to ANOVA/ANCOVA) to quantify customer response to prices. In assessments of this nature, changes in consumption patterns in response to a change in price can be quantified using the concept of "price elasticity." The larger a customer's price elasticity, the more he or she changes consumption in response to a change in the price. Price elasticity would be calculated for each of the application groups that are exposed to a change in rate structure.

The results of previous assessments have shown that customers equipped with "enabling technologies" such as programmable communicating thermostats (PCTs), tend to have higher price elasticities than customers who do not have those technologies. Other factors also influence a customer's price elasticity. For example, customers with central air conditioning (CAC) have been found to have larger price elasticities than customers without CAC. A well-developed model will capture the effects of these factors and allow for the measurement of price elasticities across many segments of customers.

[24] Statistical significance of the difference is measured by the p-value, which is compared to a pre-specified confidence threshold to conclude whether the difference is significant.