Advanced Metering Infrastructure – Implications for Residential Customers in New Jersey

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1. Executive Summary

This paper describes the major concerns for residential customers regarding the cost-effectiveness of potential utility investments in Advanced Metering Infrastructure (AMI). These concerns, which also apply to customers in other rate classes with annual usage similar to residential customers, have been raised in various reports and proceedings in other jurisdictions. This paper presents New Jersey specific implications of AMI based upon a review of the studies and filings made by NJ electric distribution companies (EDCs).

At least two New Jersey EDCs, Atlantic City Electric (ACE) and Public Service Electric and Gas (PSE&G), have proposed investments in AMI. They maintain that these investments can be justified by the savings in utility operating costs expected from AMI plus the savings to ratepayers from voluntary reductions in electricity use in response to very high prices during "critical peak periods". The critical peak periods (CPP) would typically occur 8 to 12 days each summer when electricity demand is very high due to weather conditions, and last 4 to 5 hours each time. Thus the reductions are expected to occur in approximately 50 hours, or 0.6% of the hours in the year.

Functionality. AMI technology provides a utility with the capability to reduce the costs of operating its distribution system by automating various functions that its staff now perform manually, including reading customer meters and turning power on- and off at the customer meter. The utility can also use AMI to "enable" customers to reduce their electricity use, particularly during high-price hours a few days every summer, by sending time-differentiated prices to the customer via the meter and recording the customer's actual hourly usage. (Time-differentiated pricing includes a range of approaches, ranging from hourly prices to what AMI proponents refer to as "dynamic" pricing, i.e., very high prices during CPP and prices close to existing levels during off-peak periods). It is important to note that AMI technology, in and of itself, does not reduce customer electricity use. Instead, each customer must decide to take one or more actions in response to the price signals in order to actually reduce his or her hourly usage relative to their reference or baseline usage.

Alternative Approaches. Utilities who propose investments in AMI typically propose replacement of all existing meters with new meters, a new network for two-way communication with those new meters and a new or upgraded computer system to support that enhanced communication and data collection. AMI falls under the category of "smart meters" or a "smart grid". However it is important to note utilities have a range of technologies and configurations from which to choose in order to reduce the costs of operating their distribution systems and improve communication with customer meters. For example, many utilities have invested in Automated Meter Reading (AMR) systems. Other utilities have invested in control technologies and customer meters on only those circuits where those investments are clearly cost-effective, i.e., targeted investments and replacements rather than universal replacement of all existing meters.

Savings to utility. The AMI filings of utilities in other states, and the studies prepared by New Jersey EDCs, indicate the total cost of AMI, measured as the net present value (NPV) of revenue requirements over 15 years, would be greater than the NPV of forecast savings in utility operating costs over the same period. The forecast savings from automating various distribution system operations range from fifty percent to seventy-five percent of the total cost. As a result, we assume that utilities who invest in AMI will eventually file for an increase in their distribution service rates in order to recover that shortfall.

Savings to ratepayers. The estimates of savings to residential customers from AMI-enabled dynamic pricing, a form of time-differentiated pricing, hinge upon three major assumptions:

- the reduction in peak use per participating customer,
- the percentage of customers who will voluntarily participate, and
- the long-term persistence of the reductions per participating customer.

There is considerable uncertainty regarding each of these assumptions despite the results from pilot projects in other jurisdictions. First, most pilots entice customers to participate through some form of “appreciation” payment and therefore provide no guidance regarding the percentage of customers who will voluntarily participate in the absence of such an incentive. Second, most pilots have only operated a few years, thus they provide little guidance regarding the long-term persistence of participation and reductions per participant.

In addition, even if one accepts the assumptions made by EDCs about AMI-enabled dynamic pricing, the economics are not particularly attractive either for those customers who participate or for residential customers in general. For example, one analysis estimates that an average residential customer would reduce his or her electricity use by 16 percent during a critical peak period in order to save approximately $1.24. If that customer had the same reduction in each CPP, and there were 8 CPPs or “events” over the summer, the customer would save $ 9.92 for the year. Based upon those estimated savings per residential customer, that analysis then assumes that fifty percent of residential customers would voluntarily choose to participate in dynamic pricing, and would continue to do so at that level of reduction for at least 15 years. Even with these three optimistic assumptions, that analysis indicates that it would take approximately 15 years for the aggregate savings from AMI-enabled dynamic pricing to offset the shortfall between the total cost of AMI and the forecast savings in utility operating costs.

Environmental benefits. Utility investments in AMI will not automatically lead to lower annual emissions of air pollutants associated with electric energy use, such as carbon dioxide and sulfur dioxide. The majority of the reductions in energy use driven by dynamic pricing occur in relatively few hours each year. Those reductions could lead to material reductions in NOx emissions, which are largely driven by electricity use in peak periods. However, reductions from dynamic pricing will not lead to significant reductions in annual emissions of carbon dioxide and sulfur dioxide which are a function of annual electricity use.

Conclusion. Utility investments in AMI are not the least cost approach to reducing the annual energy use of residential customers in New Jersey, or the bills and air emissions associated with that annual energy use. Those reductions in annual electricity use, annual bills, and annual air emissions can be achieved at less cost through investments in energy efficiency and voluntary participation in direct load control programs.

2. What is AMI and Why Are Some Utilities Considering It?

An AMI system typically consists of three components – a “smart meter” at the customer’s premise, a communications network between the smart meter and the utility, and a “meter data management application” (MDMA) at the utility.

The smart meter has the ability to relay price signals to controls within the home. However, the AMI system does not include any controls within the home. The smart meter also has the ability to record and store hourly usage data, to report status of power supply, and to turn power for the entire home off or on (i.e., remote disconnection or connection of service).

The communications network has the ability to send prices and control signals to the smart meter, as well as to collect information from the meter including whether the home is receiving power, whether certain appliances are on or off, and hourly electricity use.

The MDMA is computer hardware and software that can process the hourly usage data collected by the meter and transmitted on the communication network.

Again, it is important to reiterate that an AMI system does **not** include any controls on the customer side of the meter, i.e., within the residence, such as switches or thermostats that would control appliances in response to the price signals. Customers who participate, or utility customers as a whole[1], would have to pay for any such controls within their homes.

The meters and communication systems utilities currently use for residential customers typically do not have this functionality. Instead, most residential meters are typically only read once a month and, as a result, the utility does not know how much electricity a particular residential customer actually uses in a given hour or period during that month. In contrast, the meters and communication systems that the utility uses to serve its large usage customers in the commercial, institutional and industrial sectors do have the ability to record actual customer usage by hour.

The major forecast benefits to a utility from an investment in AMI are expected savings in the costs of operating their distribution systems. In particular an investment in AMI would enable utilities to control and read meters electronically and thereby eliminate staff currently required to read meters and to turn power on- and off at the meter. This would produce a reduction in the utility’s annual labor costs.

The major forecast benefits to ratepayers from a utility investment in AMI are expected savings in the summer month bills of the sub-set of customers who voluntarily reduce their usage in response to the prices, or rebates, in critical peak periods. The AMI system would “enable” the customer to achieve those reductions by providing the price signals and by recording the customer’s actual usage in response to those prices. A recent report prepared for the National Regulatory Research Institute (NRR) identifies

[1] If costs of controls for participants in dynamic pricing are included in amount to be recovered from all ratepayers.

numerous questions regarding the cost-effectiveness of these pricing approaches if they require an investment in AMI.[2]

Alternative Approaches

Utilities who propose investments in AMI typically propose replacement of all existing meters with new meters, a new network for two-way communication with those new meters and a new or upgraded computer system to support that enhanced communication and data collection. AMI falls under the category of “smart meters” or a “smart grid”. However it is important to note utilities have a range of technologies and configurations from which to choose in order to reduce the costs of operating their distribution systems and improve communication with customer meters.

One alternative is Automated Meter Reading (AMR), which is less powerful (less functionality) than AMI but does enable the utility to reduce its meter reading costs and offers the possibility of enabling some form of dynamic pricing for the subset of customers who would voluntarily choose that approach. Over the past ten years numerous utilities have invested in AMR. It is possible that a utility with an AMR system could offer dynamic pricing on a targeted approach, i.e., to only those customers who wish to participate in dynamic pricing.

Other utilities have invested in load control and supporting infrastructure for only those circuits where such investments are clearly cost-effective. This targeted investment approach would very likely be much less expensive than an AMI approach that entails universal replacement of all existing meters and investment in supporting hardware and software. Under a targeted approach the utility targets its deployment of the necessary technologies to those circuits that are about to be over-loaded and/or that serve customers who exhibit a strong response to extreme weather conditions, e.g. hot summer days. A deployment strategy that is specific to the program design characteristics should prove to be significantly more cost effective than ones that take a blanket deployment approach as some segments of the system will not provide a cost effective demand response.

[2] Brockway, Nancy. *Advanced Metering Infrastructure: What Regulators Need to Know About Its Value to Residential Customers*. National Regulatory Research Institute, Columbus, Ohio. February 13, 2008.

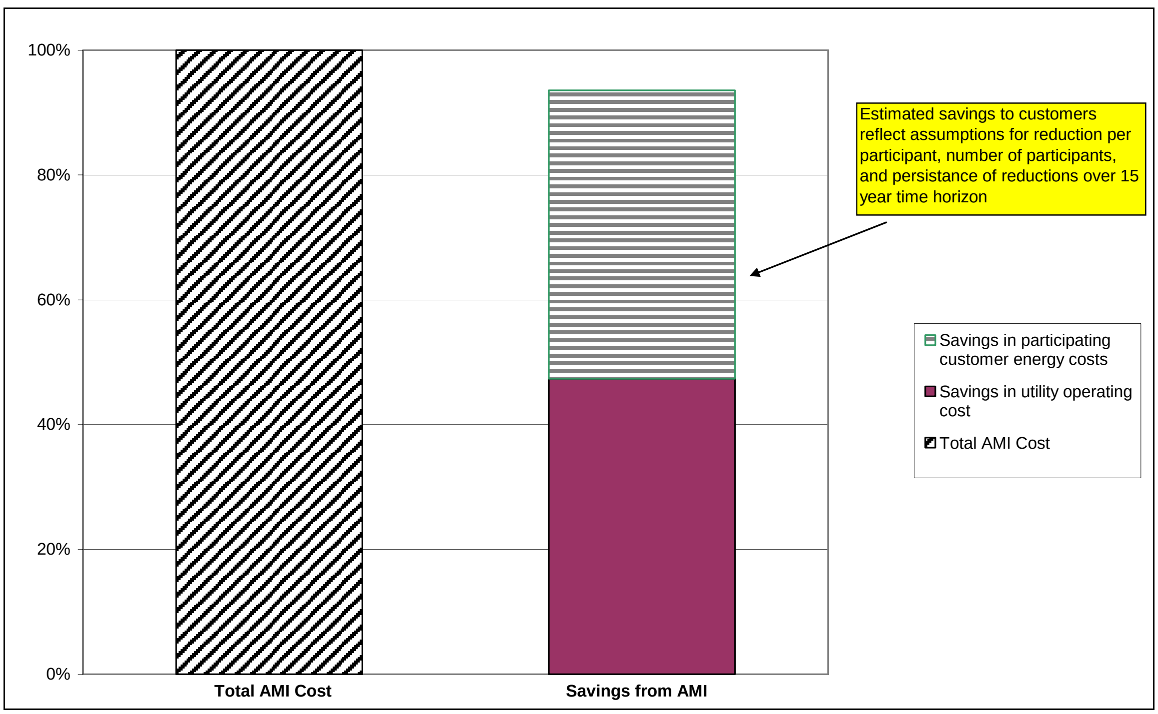
3. Forecast Savings in Utility Operating Costs from AMI Are Typically Not Large Enough to Justify an Investment in AMI

Investments in AMI lead to applications for rate increases because the projected savings in utility operating costs do not offset the full cost of the AMI investment. Instead those savings only offset a portion of that total investment.

A review of utility AMI proposals in California and Maine indicates that the forecast savings in utility operating costs from AMI systems are less than the total costs of these systems. The percentages range from 60% to 90%, with most closer to 60%[3]. Atlantic City Electric is projecting operational savings of approximately 50% of total AMI costs.[4] In these situations the utility proposing the investment in AMI typically projects savings to ratepayers from AMI-enabled dynamic pricing to help justify the investment.

The general relationship between the total cost of a utility investment in AMI, the projected savings in utility operational costs and the projected savings to ratepayers is shown in Figure 1. Note that Figure 1 does not include any additional investment on the customer side of the meter, such as switches or thermostats, which a customer might purchase to control individual appliances.

Figure 1 – Total Cost of AMI versus Savings in Utility Operating Costs Over 15 Years



[3] CA PUC, Decision 06-07-027, page 10; Pacific Gas and Electric Application 07-12, December 12, 2008 (sic), pages 8 and 9; C PUC, Decision 07-04-043, page 22; Rebuttal testimony of Stephen George, Maine PUC Docket 2007-215, pages 2 and 3

[4] Docket EO07110881, Atlantic City Electric "Blueprint for the Future" filing, November 19, 2007, Exhibit B, page 7

We expect that any utility in New Jersey that is proposing an AMI system, such as Atlantic City Electric, will eventually file for an increase in distribution service rates in order to recover the shortfall between the total cost of the AMI system and the projected savings in operating costs. (A utility that expects savings in annual operating costs from AMI to exceed the total cost of its AMI system would have no reason to seek recovery through a rate case filing. Instead, the utility could simply invest in AMI and reap the benefit of the resulting savings in operating costs in the form of higher earnings.)

4. Estimates of Incremental Savings to Ratepayers from AMI-enabled Dynamic Pricing Hinge upon Three Uncertain Assumptions

The estimates of savings to residential customers from AMI-enabled dynamic pricing hinge upon three key assumptions - the average reduction per participating customer, the number of customers who will participate and the long-term persistence of their reductions.

Dynamic Pricing

AMI-enabled dynamic pricing is simply a type of time-of-use or time-differentiated pricing. The utility uses the AMI system to "enable" customers to reduce their electricity use, particularly during CPPs. Under this approach the price for electricity use during a CPP is set quite high, perhaps five times greater than the normal rate, for example $0.80 per kWh versus $0.16/kWh. The utility notifies participating customers approximately one-day in advance of an upcoming CPP and uses the AMI system to record the customer's actual hourly use during the CPP. In order for participating customer to be reimbursed for a "reduction" during the CPP, the utility would compare the customer's actual use during the CPP to that customer's typical use. Thus, a customer's reduction during a critical peak on a Wednesday afternoon in July would be determined by comparing the customer's actual usage during that critical peak to its typical or baseline usage for Wednesday afternoons during July.

Dynamic pricing is distinct from utility direct load control (DLC) programs. Under a DLC program a customer allows the utility to control his or her central air-conditioning during CPPs. Since utilities do not require an AMI system to operate DLC programs, the reductions from DLC cannot be attributed as a benefit of AMI. In addition, since customers on DLC receive an incentive under the DLC program, dynamic pricing does not apply to their reductions in usage from DLC,

Assumption 1 – Average Reduction in Electricity Use during CPP by Participating Customers

Unlike DLC, an AMI system does not in any way "automatically" reduce customer electricity use. Instead, in response to the CPP price each participating customer must decide to take one or more actions in order to actually reduce his or her hourly usage relative to their reference or baseline usage. Those actions could include

- turning their central air conditioning down, or off, if they are not in a DLC program,
- turning window air conditioning unit(s) down, or off
- shifting clothes washing and drying from the CPP to another time
- turning a dehumidifier off
- shifting baking or dishwashing to another time

A Brattle Group[5] study of the benefits of AMI prepared for ACE estimated the average reduction in usage by residential customers who respond to dynamic pricing during critical peak periods based upon experience from other jurisdictions. Table 1 presents those estimated reductions, and the corresponding savings based upon a CPP price of $0.828/kWh.[6] For a residential customer on a DLC program, the value of incremental reductions in response to dynamic pricing (i.e., incremental to DLC reductions) is approximately $0.83 per event. For a residential customer not on a DLC program, the value of reductions in response to dynamic pricing is approximately $1.24 per event. Thus, for example, in a year with 8 critical peak periods or "events" these customers would save between $6.64 and $9.92. In contrast, New Jersey residential customers who participate in a DLC program receives either a free thermostat (installed), a $ 300 value, or $ 4 per month for June through September plus $1 per event (an annual value of $24 in a year with 8 events).

[5] Docket EO07110881, Atlantic City Electric "Blueprint for the Future" filing, November 19, 2007, Exhibit C, page 16

[6] Ibid, page 24

Table 1
Estimated Reductions and Savings of Residential Customers During Critical Peak Periods

Program (Customer segment)	Reduction in Peak Use during Critical peak			Duration of critical peak (# of hours)	Price or rebate in critical peak period ($/kW)	Payment for reduction in each critical peak[7] $	Annual Payment in a year with 8 critical peaks[8] $
	Source of reduction	Size of reduction (kW)	Size of reduction as % of peak use				
Direct Load Control (Customers with central air conditioning)	Utility cycling of central air conditioning	1.2	48%	5	DLC participant incentives under DLC programs vary according to whether they have switches or thermostats.		
Dynamic Pricing – Residential customer in DLC program	Incremental Customer reductions in use of electricity (incremental to DLC reductions)	0.2	8%	5	$0.828	$0.83	$ 6.64
Dynamic Pricing – Residential customer not in DLC program	Customer reductions in use of electricity (other than central air-conditioning	0.3	16%	5	$0.828	$1.24	$ 9.92

Assumption 2 - Percentage of Customers Who Would Voluntarily Participate in Dynamic Pricing

Estimates of the percentage of residential customers who will voluntarily participate in, and respond, to dynamic pricing need to be scrutinized closely to determine if they are consistent with actual experience in other jurisdictions. For example, the Brattle Group study prepared for Atlantic City Electric estimates that, by 2014, approximately 50% of all residential customers would voluntarily participate in, and respond to dynamic pricing. That estimate, prepared by the Brattle Group, consists of all residential customers forecast to be participating in the ACE DLC program[9] plus 20% of the residential customers who are not participating in DLC.

Both components of that estimate are uncertain. The first component is the estimate of the number of residential customers who would be on DLC by 2014. The Brattle Group estimates that approximately 200,000 residential customers of ACE will be on DLC by

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7 Quantity of reduction (kW) * hours * price in CPP

8 Payment for reduction in each CPP * number of CPP per year

9 Docket EO07110881, Atlantic City Electric “Blueprint for the Future” filing, November 19, 2007, Exhibit C, pages 27 to 29

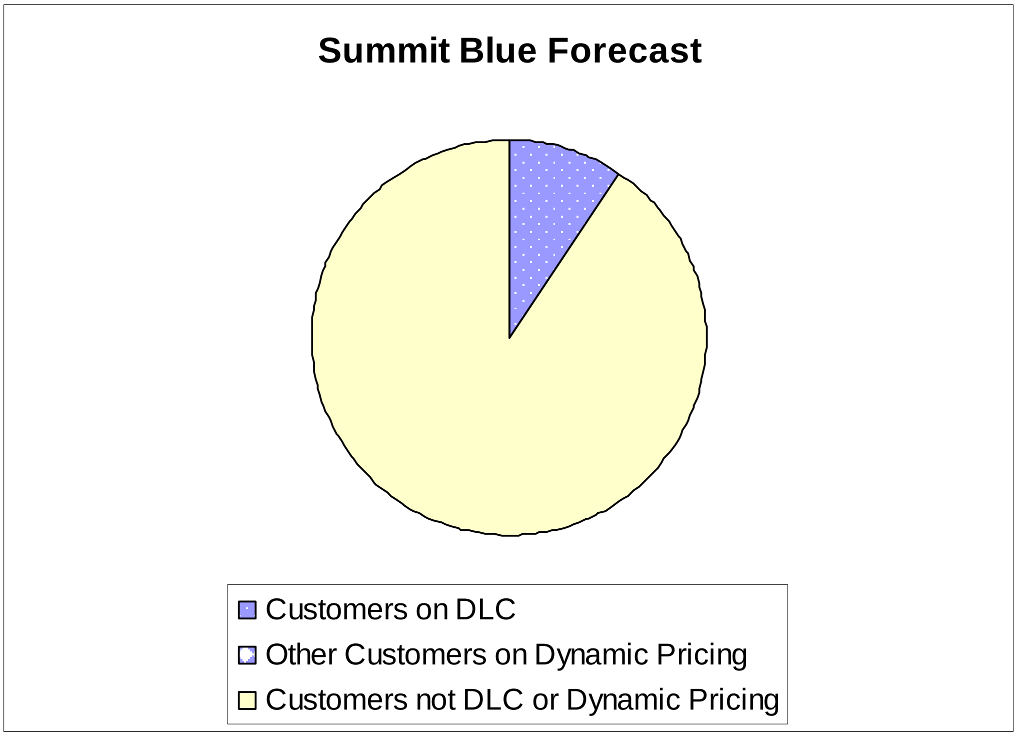
2014. This represents approximately 67% of residential customers with central air conditioning. Given the Company's assumption that about 55% of residential customers will have central air-conditioning, their participation estimate equates to 37% of all residential customers (i.e., 67% of 55% = 37%). The estimate of 67% participation is four times higher than the projection by another consultant, Summit Blue[10], of 17 percent. Summit Blue estimated that 17% of New Jersey residential customers with central air conditioning would participate in DLC if given the opportunity. Summit Blue developed their projection after reviewing actual participation levels in a number of DLC programs around the country. The Summit Blue estimate reflects various factors that limit participation by customers with central a/c, including the percentage of customers who would not be at home during critical peak events and the percentage that is either unable or unwilling to participate. The Summit Blue DLC participation estimate equates to 9% of all residential customers (i.e., 17% of 55% = 9%).

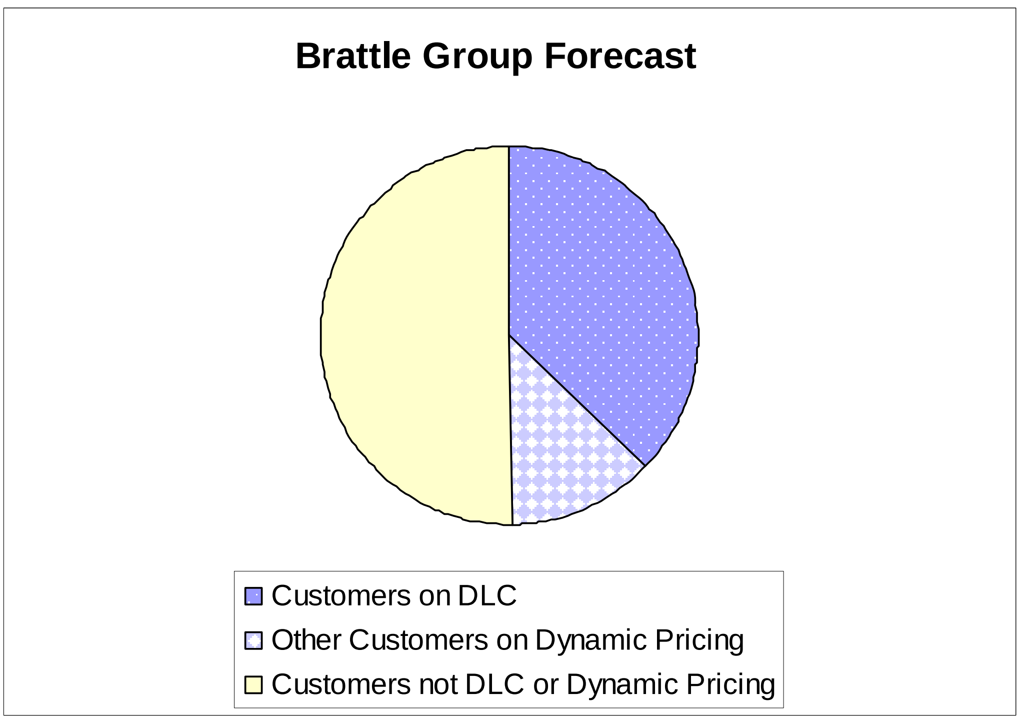
The second component is the estimate that 20 percent of residential customers not on DLC would voluntarily participate in dynamic pricing. That estimate is also open to question. If those customers are not on DLC it appears that they do not have central air conditioning, which offers the best opportunity to achieve significant reductions in electricity usage during critical peaks. Customers can turn other electric appliances down or off during peak periods, and shift some actions to off-peak periods, but these loads are much smaller than central a/c and hence produce much smaller savings. To the extent that this estimated participation is based upon participation by customers in pilots elsewhere, it is important to note that almost all such pilots use "appreciation payments" to elicit that participation. Therefore one can not draw any conclusions regarding the level of voluntary participation in the absence of such payments.

An illustration comparing the estimates of participation in DLC by Summit Blue, and in DLC plus dynamic pricing by the Brattle Group, is presented in Figure 2.

[10] Summit Blue Consulting, *New Jersey Central Air Conditioner Cycling Program Assessment*, June 4, 2007, page 47.

Figure 2: Forecasts of Residential Customer Participation in Direct Load Control (DLC) by Summit Blue and in Dynamic Pricing by Brattle Group





Assumption 3 - Long-Term Persistence of Reductions

The third key assumption underlying the estimated NPV of savings to residential customers from AMI-enabled dynamic pricing is the long-term persistence of the reductions of participating customers. The reductions during critical peaks must persist year after year for many years in order to actually avoid capacity costs as well as to aggregate over time to a meaningful NPV.

The primary source of savings from customer reductions in electricity usage during critical peaks are capacity costs that BGS suppliers serving those customers can "avoid" due to those reductions. However, in order for a BGS supplier to avoid the need to acquire that capacity it must demonstrate to PJM, the entity responsible for ensuring reliable service, that this is a long-term persistent reduction rather than a one-year or temporary phenomenon. A long-term reduction is essential because it takes several years in order to bring new capacity into service. Because of that lead-time PJM sets the quantity of capacity that a BGS supplier must hold to ensure reliability, referred to as its Installed Capacity requirement, several years in advance based upon a forecast of customer load during critical peaks. In order for PJM to accept a reduction during future critical peaks for capacity planning purposes it will need to be convinced that the reductions will persist in the long-term.

The long-term persistence of reductions in critical peak usage by customers on AMI-enabled dynamic pricing is unclear. The dynamic pricing pilot studies conducted elsewhere have only operated for a few years. The experience with time-of-use pricing in the past indicates that many customers tended to decrease their price-driven reductions after several years.[11]

Estimated Aggregate Savings to Ratepayers over 15 Years

The aggregate savings from the group of customers on AMI enabled dynamic pricing are less than the shortfall between the total cost of AMI and the forecast savings in utility operating costs. This was illustrated in Figure 1 based upon projected savings in electricity supply costs for the subset of customers forecast to voluntarily participate in the dynamic pricing "enabled" by AMI.

[11] Brockway, Nancy. *Advanced Metering Infrastructure: What Regulators Need to Know About Its Value to Residential Customers*. National Regulatory Research Institute, Columbus, Ohio. February 13, 2008.

5. AMI-Enabled Dynamic Pricing Will Not Produce Significant Reductions in Annual Air Emissions Associated With Annual Electricity Use

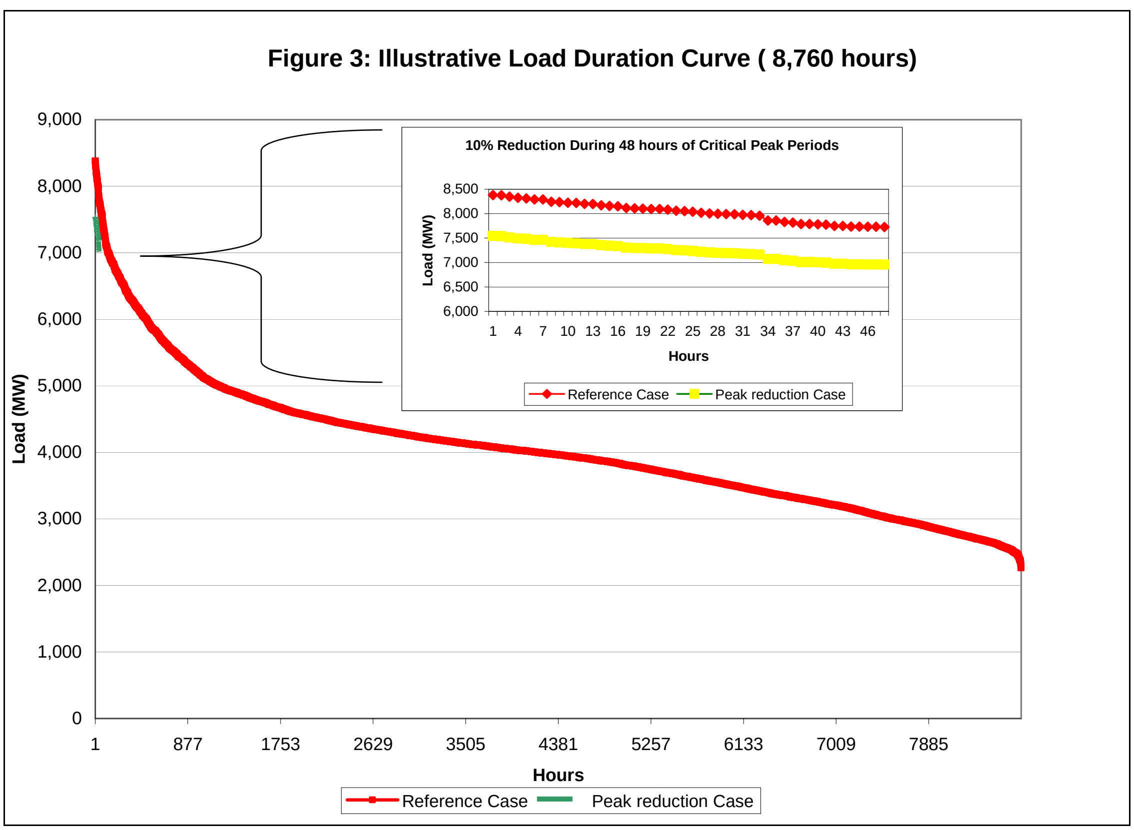
Utility investments in AMI will not automatically lead to lower annual emissions of air pollutants associated with annual electric energy use, such as carbon dioxide.

The majority of reductions in electricity use in response to AMI-enabled dynamic pricing are expected to occur during critical peaks, approximately 50 hours per year. In fact, the Brattle Group study prepared for ACE indicates that it expects participants to shift use from peak periods to off-peak periods, rather than completely reducing net electricity use.

Those reductions in electricity use during critical peak periods could reduce the number of hours older peaking units operate. Such reductions could in turn reduce nitrogen oxide emissions during those critical peaks and represent material reductions in annual NOx emissions, which are largely driven by electricity use in peak periods.

However, reductions from dynamic pricing will not lead to significant reductions in annual emissions of carbon dioxide and sulfur dioxide, since those emissions are a function of annual electricity use. In order to reduce annual air emissions from existing generating units significantly, and to delay the need for new generating units, customers must reduce their annual electricity use significantly.

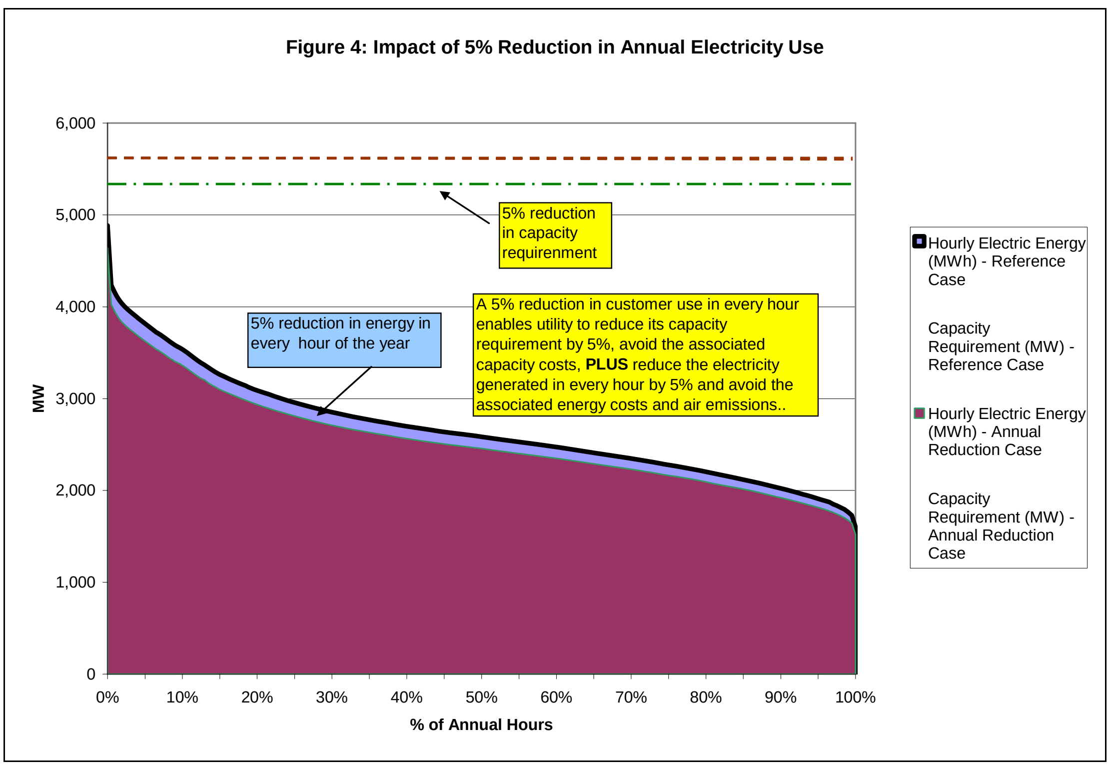
Even if all residential customers reduced their usage by 10% in 48 peak hours each year, annual air emissions would not be reduced materially. This is illustrated in Figure 3.



6. AMI-Enabled Dynamic Pricing is Not the Best Approach to Reducing Annual Electricity Use, and the Annual Bills and Annual Air Emissions Associated with that Annual Use

Utility investments in AMI are not the best approach to reducing the annual energy use of residential customers in New Jersey, or of the annual bills and annual air emissions associated with that annual electricity use. Those resource and cost savings can be achieved at less cost through investments in energy efficiency and direct load control. Neither of these existing programs requires AMI.

The difference in impacts between a reduction in electricity use during a few critical peaks, and a reduction in annual electricity use is illustrated in Figure 4. This chart illustrates the impact of a 5% reduction in annual energy use. In this example, customers install energy efficiency measures which reduce their electricity use by 5% in every hour of the year (e.g., 8,760 hours). In response to this permanent reduction BGS suppliers could reduce the quantity of capacity they hold by 5%, as well as reduce the quantity of electricity that needs to be generated in every hour by 5%. This 5% annual electricity generation reduction would produce a corresponding decrease in a participating customer's annual bill. It should also provide a corresponding reduction in air emissions, including avoided carbon dioxide associated with the avoided electric energy.



Conclusion

As this paper shows, utility investments in AMI are not the least cost approach to reducing the annual energy use of residential customers in New Jersey, or the bills and air emissions associated with that annual energy use. Those reductions in annual electricity use, annual bills, and annual air emissions can be achieved at less cost through investments in energy efficiency and voluntary participation in direct load control programs.