BEFORE THE MARYLAND PUBLIC SERVICE COMMISSION

CASE NO. 9208

IN THE MATTER OF

BALTIMORE GAS AND ELECTRIC COMPANY

FOR AUTHORIZATION TO DEPLOY A

SMART GRID INITIATIVE

AND TO ESTABLISH A SURCHARGE MECHANISM

FOR THE RECOVERY OF COST

DIRECT TESTIMONY OF NANCY BROCKWAY

ON BEHALF OF THE

MARYLAND OFFICE OF PEOPLE'S COUNSEL

OCTOBER 13, 2009

TABLE OF CONTENTS

EXHIBITS

I. INTRODUCTION

Q. Please state your name, your business affiliation, and your address.

A. My name is Nancy Brockway. I am the principal of NBrockway & Associates, a firm providing consulting services in the areas of energy and utilities. My address is 10 Allen Street, Boston, MA 02131.

Q. On whose behalf are you testifying in this proceeding?

A. I am testifying on behalf of the Maryland Office of People's Counsel (OPC).

Q. Please briefly describe your qualifications and experience.

A. Since 1983, my professional focus has been the energy and utility industries, with particular attention to the role of regulation in the protection of consumers and the environment. I was a Commissioner appointed to the New Hampshire Public Utilities Commission, serving from 1998 to 2003. Earlier, I was for several years a hearing officer and advisor to the Maine Public Utilities Commission and then to the Massachusetts Department of Public Utilities, where I served two years as General Counsel of the commission. I was an expert witness on consumer and low-income utility issues for seven years, with the National Consumer Law Center. Since leaving the New Hampshire Commission, I have been a consultant on regulatory utility issues to regulatory commissions, ratepayer advocates, low-income energy groups, and others. I also spent several months serving as the Director of Multi-Utility Research and Analysis with the National Regulatory Research Institute. While at NRRI, I researched and wrote a key objective study of the impact of advanced metering structure and related pricing options on residential consumers. I have written comments and filed testimony in the

Massachusetts Smart Grid proceedings now ongoing. My resume is attached as Exhibit NB-1.

Q. Have you previously testified before this Commission?

A. No.

Q. Have you testified on utility matters before other Commissions?

A. Yes. I have filed testimony in over thirty proceedings. I have appeared before fifteen state or provincial regulatory commissions.

Q. What is the purpose of your testimony today?

A. I have been asked to review the Smart Grid filing of Baltimore Gas & Electric (BGE or Company), to:

- analyze the evidence regarding the likely residential demand and energy reductions enabled by the Company's proposed Smart Grid program,
- review uncertainties in the evolution of smart grid technology that could affect costs and timing of prudent investments,
- review potential adverse impacts of the Company's proposed Smart Energy Pricing (SEP)/time-of-use (TOU) rates on vulnerable customers.
- evaluate the merits of the proposal to put residential customers on mandatory TOU rates at this time,
- analyze the impact of the proposed Smart Grid program on residential consumer rights and protections, and
- make recommendations for mitigating adverse impacts associated with the proposed Smart Grid program.

Q. Is your testimony intended to be a stand-alone presentation?

A. No. My colleague J. Richard Hornby, of Synapse Energy Economics, Inc. is presenting testimony dealing with, among other things, the analysis of costs and benefits for the proposed Smart Grid deployment. He will discuss the extent to which uncertainties in key assumptions that I discuss bear on the strength of the cost-benefit analysis. My colleague David J. Effron, of Berkshire Consulting Services, is presenting testimony to address the Company's request to establish a tracker mechanism to recover the costs of the Smart Grid Initiative.

II. DESCRIPTION OF BGE SMART ENERGY PRICING PROPOSAL

Q. Please describe BGE's Smart Energy Pricing proposal.

A. BGE first proposes to deploy an advanced metering infrastructure (AMI) composed of advanced meters, radio-based communications equipment, IT components to operate the AMI system and store meter data, and computer software integrations. (Butts Direct, p. 19). In 2012, when this infrastructure is projected to be in place, BGE proposes to move all residential electric customers to a new rate structure which it calls Smart Energy Pricing (SEP). Under the SEP, all residential customers will be on TOU rates, under which generation rates are higher for summer on-peak periods (weekdays from 2PM to 7PM, excluding holidays), and lower at other times. (Butts Direct, p. 3). In addition, under the SEP, all residential customers will be able to earn Peak Time Rebates (PTR) if they reduce their load during so-called critical peak periods. (Manuel Direct, p. 4).

Q. Please describe the critical peak periods during which residential customers, under SEP, will be able to earn Peak Time Rebates.

A. Critical peak periods would be those peak hours (2PM - 7PM) on summer days when demand on the system is particularly high. They include peak hours on days when PJM has declared an emergency. The Company expects to call 12 critical peaks in a normal summer, but could call more or fewer, mostly depending on the weather. (Manuel Direct, p. 4).

Q. Will the Company continue its PeakRewards[SM] direct load control program for customers with central air conditioning or an electric heat pump?

A. Yes. The PeakRewards[SM] program will continue. (Application, p. 10). Under this direct load control initiative, which BGE has run successfully in various forms since the late 1980's,[1] the customer allows BGE to install a smart thermostat or a remotely-controllable on/off switch on their central air conditioning unit. The customer gives BGE the authority to directly control the thermostats or switches on their air conditioning, and cycle the units off (e.g. during critical peaks) in exchange for a billing credits of $50, $75 or $100, depending on the extent of cycling the customer allows BGE to exercise.[2] In the first year of participation, there is a matching bonus as an inducement for participation. BGE also provides rewards to electricity customers who allow the utility to install a switch on their hot-water heaters, and permit BGE to cycle the water heaters off. PeakRewards[SM] customers will be on the SEP rate, and be eligible for peak time rebates, along with other customers, but only for that portion of their demand response that is in excess of the demand reduction brought about by the utility's cycling of their air

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[1] Available at http://www.peaklma.com/documents/Greenberg.pdf.

[2] Available at http://peakrewards.bgesmartenergy.com/save-money/index.php. This website and the linked pages are the source of the information as to the PeakRewards[SM] program.

conditioning or water heater. (Exh. DMV-1 at 13). Approximately 36% of residential (and small commercial) customers are PeakRewards^{SM} A/C customers. (*Id*).

III. BGE ESTIMATES OF DEMAND AND ENERGY SAVING

Q. Please describe the assumptions made by the Company in this docket concerning customer participation and associated demand and energy savings from its "Smart Energy Proposal."

A. Under the BGE proposal, all residential customers will be placed on the SEP rate (TOU plus PTR). The SEP rate itself will be mandatory; it will be the default residential rate, and customers will not be free to opt out. (Application, p. 11). Thus, 100% of the residential customers will be taking service under SEP. This includes the roughly 36% of customers who are or will be in the PeakRewards^{SM} program and have central air conditioning load control, and the residual 64% of customers who are not in the direct load control program (Exh. DMV-1, p. 13). To estimate the level of demand reduction that will be achieved in response to the incentives of the PTR rate, BGE determines what portion of each group (PeakRewards^{SM}-A/C, and all other residential consumers) will respond, and what portion will show no demand reductions in response to the PTR inducements. According to Mr. Vahos, BGE estimates that 70 % of all non-PeakRewards^{SM} AC residential customers will "engage" with the SEP opportunity. BGE assumes that this roughly 45% of all residential customers (70% times 64%) will exhibit an average peak load reduction of .73 kW (*Id.*). BGE assumes 90% of its PeakRewards^{SM} A/C customers [or a weighted average of 32% of all residential customers (36% times 90%)] will reduce load at critical peaks by 0.15 kW beyond their direct load control contribution (*Id.*). BGE assumes the remaining customers (30% of the

64% and 10% of the 36%) make no demand reductions in response to the peak time rebate (*Id.*).

Q. On what does BGE base these demand response estimates?

A. In his direct testimony, BGE witness Jason M. B. Manuel says the Company bases its estimates on the results of its 2008 SEP pilot, Exhibit DMV-1, as well as its assumed critical peak rebate of $1.25 per kWh/critical hour. (Manuel Direct, p. 5). According to Mr. Faruqui's Direct Testimony BGE's 2008 SEP pilot evaluator, the Brattle Group, derived a curve of demand responses to the pilot SEP offerings that varied with the size of the rebates a customer on the PTR could obtain for backing off ordinary peak loads during called critical peaks. (Faruqui Direct, p. 5). The pilot examined the impact of rebates of $1.16 per kWh of critical peak response and $1.75 per kWh of critical peak response, and translated these responses to estimates of elasticity. (Faruqui Direct, p. 7). The pilot evaluators interpolated the coordinates of the elasticities for rebate amounts between the two amounts tested in the 2008 SEP pilot. (Faruqui Direct, p. 5). The Company then identified the elasticity estimated for an assumed rebate of $1.25 (its current nomination of the value of the rebate, given assumptions about forecast capacity values, Exh. JMBM-6). It applied this estimated elasticity to the estimated numbers of customers who "engage" to estimate the demand responses it would expect from its SEP rates if those rates were now in place.

Q. **Are there sources of uncertainty in the estimate of likely demand reductions in response to the proposed SEP rates**?

A. Yes. There are three key types of uncertainty in the Company's estimate of likely demand reductions in response to the proposed SEP rates. They are the following:

- Uncertainty as to the types of customers who will respond to the SEP, as opposed to pilot participants, and their associated levels of demand response.
- Uncertainty as to the level of energy savings that will be attributable to SEP rates.
- Uncertainty as to the persistence of demand responses throughout the project forecast period.

A. UNCERTAINTY AS TO CUSTOMERS WHO WILL ENGAGE WITH SEP

Q. What do you mean by uncertainty as to the types of customers who will respond to a real rate, as opposed to pilot participants?

A. There are a number of reasons why a customer will participate in a pilot, and respond to the incentives contained in that rate. However, the motivation of the customers who participate in a pilot may not be representative of the motivations of customers generally. In social science pilots, the differences between the customers who participated in the pilot, and the universe of customers who will be on the tariffed SEP, would constitute "selection bias." This is not a pejorative term – it does not imply intentional bias, but rather simply refers to a mismatch between the pilot treatment group and the general population that could undermine the usefulness of the pilot results.

Q. How could the motivations of pilot participants be different from the average customer?

A. In the SEP pilot, participants were offered a $150 appreciation payment for their participation. (Exhibit AF-4, Appendix 2, p. 27). It goes without saying that such an inducement will not exist under the tariffed SEP. In addition, during the selection of participants, according to Company witness Dr. Faruqui, a significant number of those approached by BGE as potential participants declined the invitation or later dropped out. (Exhibit AF-2, p. 6). The evaluators could not know why some who were invited to participate declined, and all the reasons why participants would drop out. (*Id.*) It is possible that the same factors that led customers to decline the invitation or drop out of participation will affect customers in the general population, and that these customers would not show as much demand response. Of necessity, pilots are artificial situations. They involve human beings, not test tubes.

Q. What was the primary reason customers chose to enter the SEP pilot?

A. In the survey of pilot participant attitudes taken after the SEP pilot, as acknowledged in the response to OPC DR1-12, the "primary motivation" for participation, cited by almost 80% of those who chose to participate, was "to save money." In the focus groups before the SEP pilot, customers said it would not be worth participating for savings of only $5 or $6 per month. (Attachment 1 to OPC DR1-12, p. 16). At a hypothetical critical peak differential of $1.30 per kWh per critical peak hour (slightly higher than the $1.25 differential used in engagement forecasts in the BGE business case in this docket), those without central air conditioning were forecast to save only $5 per month. (*Id.* at 15).

Q. Dr. Faruqui asserts that "selection" bias in the SEP pilot was ruled out. Do you agree?

A. Not entirely. BGE used a statistical comparison of pre- and post- treatment usage of both pilot participants and the control group to address self-selection bias in the SEP pilot. (Faruqui Direct, p. 17). BGE also compared the control and treatment groups for such factors as in several attributes such as hourly loads, weather sensitivities, and appliance holdings in the pre-pilot period. (*Id.* at 4). These techniques help reduce selection bias, but cannot completely eliminate it.

Q. How could the 2008 SEP pilot not be representative of the total BGE residential customer group, given the techniques employed by the Company to address the possibility of selection bias?

A. A casual look at some literature on social science experiments produces the impression that there is some level of dispute among academics as to the effectiveness of statistical tools to reduce selection bias. It may be that the factors driving customer choices to participate in a pilot and to "engage" as customers are different. There are a large number of factors that are understood to influence consumer decision-making, and it would take an extensive pilot to capture them all.

Q. Can you provide some sense of the variation among groups of consumers?

A. As is well known, marketers routinely separate consumers into numerous discrete groups for purposes of targeting products and services, and their advertising and sales. Different firms and authors have different ways of categorizing customers. A list of commonly-used attributes for segmenting markets is provided by Steven J. Moss in his paper, *Market Segmentation and Energy Efficiency Program Design*, published in November 2008 by the California Institute for Energy & Environment:[3]

- Demographics
- Geographic (e.g., neighborhoods, feeder lies, or distribution planning areas)
- Decision pathways (e.g., individual or institution; renter or owner)
- Knowledge
- Needs
- Values
- Attitudes
- Motivations
- Preferences
- (Energy) use patterns
- Access to financing
- Access to information
- Trust levels
- Competing products
- Equipment turnover patterns
- Behaviors associated with the product and/or service

[3] Available at http://uc-ciee.org/energyeff/documents/MarketSegementationWhitePaper.pdf.

• Sensitivity to price or features
• In the case of businesses, their size in terms of employees and energy use, among other variables.

The inability of pilots to capture all of these potentially influential differences among the customer population as a whole introduces some uncertainty into the applicability of pilot results.

Q. Were there significant differences between SEP pilot participants and the control group?

A. Yes. As noted in Exhibit AF-2, Appendix 4, and the response to STAFF IR2-91, participants were more likely to own their own single-family homes, have at least a college education, have a dishwasher, own a swimming pool, cool primarily with central air conditioning instead of room air conditioners, have programmable thermostats, and have incomes above $75,000, than the control group.

Q. Are there factors present in other AMI pilots that cause you to be cautious in assuming that customers generally will respond at the same level as participants in those pilots?

A. Yes. Possible differences in pilot and tariff offerings from other pilots include the following:

- Cash incentives for participation.
- Requirement to join a membership organization with an emphasis on energy efficiency and environmental issues.
- Requirement that applicants be able to read and understand letters of solicitation sent by their utility.
- Need to be reachable by the utility within the time frame of the solicitation of interest.
- Interest in helping solve the state's energy problems or responding to an energy crisis.

Q. Can you give an example of a mismatch between pilot participants and real life customers on a critical peak tariff?

A. Yes. The experience of Pacific Gas & Electric in 2008 suggests that pilots may not provide a firm basis for estimating post-pilot participation.[4] After a pilot that indicated high average responses to critical peak pricing, PG&E introduced critical peak pricing (SmartRate™) on an opt-in basis to its customers in Bakersfield and Kern counties in California. The Company solicited 100,000 customers to participate, and about 7.5% of residential customers who received the invitation did opt to take service under the SmartRate™. Load reductions per customer were in line with per customer load reductions forecast on the basis of the California pilot. However, the initial experience with PG&E's critical peak tariff produced unexpected results as to the types of customers who opted to take service on the rate. According to the Impact Evaluation, a "disproportionate number of CARE customers enrolled in SmartRate relative to the share of CARE customers in the Bakersfield area."[5] CARE customers are low-income customers who take service under a reduced rate of the same name. The report observed that, whereas approximately 35 percent of Kern County residential electricity customers who were sent marketing materials were low-income rate customers, 56 percent of customers who enrolled in SmartRate™ in 2008 were low-income rate customers. The report also noted that, as had been expected based on the pilot, CARE customers had much lower demand reductions (both in absolute and percentage terms) than non-CARE customers on the critical peak rate. The average load reduction by CARE customers across the critical peak period for the nine critical peak days called that summer was 11.0

[4] Material on the PG&E critical peak pricing experience is drawn from Stephen George, et al. *2008 Ex Post Load Impact Evaluation for Pacific Gas and Electric Company's SmartRate™ Tariff, Final Report*, December 30, 2008.

[5] Stephen George, et al. *2008 Ex Post Load Impact Evaluation for Pacific Gas and Electric Company's SmartRate™ Tariff, Final Report*, December 30, 2008, at 4.

percent. By contrast, the average load reduction of non-CARE customers was twice as great, at 22.6 percent. One possible reason that low-income customers were over-represented among SmartRate™ customers, according to the evaluators, was that such customers were on the lookout for opportunities to reduce their bills, and associated new offerings by the utility as such opportunities.

Q. What do you infer from the PG&E experience with SmartRate™ in 2008?

A. The disproportionate take-rate for the tariff by customers with relatively low average demand responses gives rise to a question about whether pilot responses (in terms of average load reductions time numbers of participants) can be used to predict the overall load reductions that the tariff will produce.

Q. Is there further support for your opinion that estimates of demand reduction in response to AMI-supported prices are uncertain?

A. Yes. A recent Federal Energy Regulatory Commission Staff Report[6] shows that the level of customer participation and associated demand reductions are by far the most uncertain factors in estimating the impacts of AMI-supported demand response programs.

B. UNCERTAINTY IN ESTIMATES OF ENERGY SAVINGS

Q. Does the Company also estimate energy savings and associated benefits from its implementation of AMI and institution of SEP pricing?

A. Yes. The Company has assumed that overall annual energy use will decline by 1% in response to its smart meter initiative and SEP pricing. (Exh. DMV-1, p. 14).

[6] The Brattle Group, Freeman Sullivan & Co., Global Energy Partners, LLC, *A National Assessment of Demand Response Potential*, prepared for the Staff of the Federal Energy Regulatory Commission, June 2009. Note that Dr. Faruqui was a key contributor to and co-author of this report.

Q. How, according to BGE, will annual energy consumption go down by 1%?

A. BGE states that energy savings could be achieved through better energy consumption feedback to customers, such as in-home displays, web portals, or general interval usage awareness. (Response to OPC DR4-7).

Q. Does BGE ascribe any particular impacts to such feedback mechanisms?

A. No. In fact, the Company declines to ascribe any particular impacts to such feedback mechanisms, stating that the "benefit of support for In Home Devices has not been quantified." (Response to OPC DR4-2).

Q. Do the results of the California Special Pricing Project provide support for the Company's estimate of energy consumption savings as a result of SEP-type pricing?

A. No. As to overall consumption, Charles River Associates noted in the evaluation of the CA SPP, there was" essentially no change in total energy use across the entire year based on average SPP prices. That is, the reduction in energy use during high-price periods was almost exactly offset by increases in energy use during of-peak periods." (Executive Summary p. 7).

Q. The Company states that the SEP pilot showed a conservation impact of approximately half a percent. (Response to OPC DR4-7). Does this not support the Company's assumption of 1% efficiency savings?

A. No. The SEP pilot results do not support an assumption of a 1% efficiency savings from SEP. Dr. Faruqui in his Direct Testimony states that "PTRH rates,[7] regardless of the presence of the enabling technologies, lead to a 0.6 percent reduction in total monthly consumption." (Faruqui Direct, p. 26). Similarly, according to Dr. Faruqui, "PTRL rates,[8] regardless of the presence of the enabling technologies, lead to a 0.5 percent

[7] Manuel Direct, p. 7. The piloted peak time rebate tariff with the higher rebate level, $1.75 per critical peak kWh.

[8] *Id.* The piloted peak time rebate tariff with the lower rebate level, $1.16 per critical peak kWh.

reduction in total monthly consumption." (Faruqui Direct, p. 26). Note that the piloted peak time rebate closest in magnitude to the projected $1.25 per critical peak kWh used in estimating impacts for the SEP tariff was the one offered in the PTLR, which makes the smaller of the two consumption impacts more relevant. Whether the reduction was 0.6% or 0.5%, however, a pilot reduction of only half the amount claimed in the SEP business case does not support the assumed energy savings benefits in the business case. In addition, pilot consumption reductions were observed only during the four months June through September. (Exh. AF-2 pp. 4-5, and Appendix I). Given the assumption of no usage change in off-peak periods (Exh. AF-6), the admittedly modest consumption impact during this third of a year cannot provide the basis for assuming an annual 1% consumption impact.

Q. You have noted that the Company states energy consumption can be reduced by giving customers feedback on prices and usage. Do the pilot results bear this out?

A. No. As I noted above, the Company does states that the claimed energy savings could be achieved through better energy consumption feedback to customers, such as in-home displays, web portals, or general interval usage awareness. (Response to OPC DR4-7). In addition, the Company claims that a 2006 summary[9] (the "Darby" summary) of results of various studies of the value of "feedback" to customers about their energy usage supports its assertion that its 1% estimate of energy reduction (in response to SEP price signals and the availability of data on the web portal) is conservative. (Butts Direct, pp. 10-11). However, not only did the Company not quantify consumption savings from such feedback, as noted above, the pilot results do not support the idea that feedback makes a difference. There was no difference in consumption impacts between pilot

[9] Sarah Darby, The Effectiveness of Feedback on Energy Consumption (Feedback), University of Oxford, 2006.

participants who received no feedback other than prices, participants who received the price signal of the peak time rebate plus an Energy Orb to provide notice of high-priced periods, and participants who received feedback in the form of the price signal, the Orb and also enabling technologies such as a switch to cycle the air conditioning in response to critical peak hours. (Faruqui Direct, p. 26). Note that during the pilot period, those on the critical peak price pilot increased their consumption,

Q. Does the Darby study cited by the Company support the Company's expectations as to energy reductions from its SEP prices and advanced metering infrastructure?

A. The cited study does collect some apparent support for the notion that some kinds of feedback can induce energy conservation. However, the results cited in the study are mixed, some of the often-cited studies are not relevant to North America, and the studies do not yet answer all the relevant questions, as can be seen from a review of the studies Darby reviewed. Darby looked at a total of 38 studies. However, only 18 of them were related to the kinds of feedback that BGE asserts will lead to conservation, such as in-home displays, web portals, or general interval usage awareness. Ten of the relevant studies were done in Europe; Darby herself acknowledges that cultural and other differences can affect the results. (Response to Staff_DR4-5, Attachment 3, Oxford report, p. 9). Of the 18 relevant studies, six included intensive education (such as home visits or conservation affinity groups), which is not proposed for the BGE service territory. Seven of the 18 had no controls, or very small sample sizes. Fourteen were done before 2000, of which 8 were performed before 1990. Half the studies ran 5 months or fewer, with 6 running only 1 or 2 months in total.

Q. What do you conclude about the reliability of the Darby paper and similar compilations of studies of feedback pilots in predicting usage reductions in response to feedback?

A. The Darby study and similar compilations of studies published to date cannot support robust predictions about energy conservation responses to feedback on electricity usage and bills. Utilities should be cautious about relying on the promise of energy savings from AMI-facilitated feedback to justify expenditures on AMI.

Q. Is there further support for your view that utilities should be cautious in assuming any energy savings from installation of hourly metering?

A. Yes. The Electric Power Research Institute (EPRI) recently issued a comprehensive report on the state of current knowledge about the effects of "feedback" on customer usage behavior.[10] EPRI reviewed the studies relied on by BGE in developing its estimate of a conservation effect (energy savings). In this meta-study, EPRI concluded that "residential electricity use feedback" can be an effective tool. However, EPRI cautioned that further research is necessary on such points as "participation levels, the persistence of feedback effects, the relative value of different types of feedback, dynamic pricing interactions, and distinguishing the effects of feedback among different demographic groups." (Feedback Research Synthesis, Executive Summary, p.i). EPRI's identification of gaps in the state of our knowledge about impacts of feedback is attached to my testimony as Exhibit NB-2.

Q. With respect to energy consumption changes associated with Smart Meter pilots in North America, what do the evaluations show?

A. It is hard to evaluate the change, if any, in energy consumption brought about by Smart Meter prices and associated initiatives. Not all demand response pilots estimate energy consumption changes associated with the pilot treatments. Where they do, estimates of

[10] *Residential Electricity Use Feedback: A Research Synthesis and Economic Framework.* EPRI, Palo Alto, CA: 2009. 1016844 (*Feedback Research Synthesis).*

energy consumption changes in evaluations of Smart Meter pilots in the United States and Canada range from modest usage reductions to actual usage *increases*. There are a number of hypotheses about what prompts customers to change their usage, up or down. But there is little focused research that can tell us why this pilot showed no consumption change, that pilot showed consumption reductions, and this pilot showed consumption increases.

Q. Please provide some examples of instances in which customers increased usage while participating in a Smart Meter demand response pilot.

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A. There are a number of examples of energy usage increases in Smart Meter pilots. In the California Special Pricing Program, in one mild-temperature period, customers in one treatment group increased load by 8 percent.[11] In a real time pricing pilot fielded by the Pacific Northwest National Laboratory, peak load decreased by 15 to 17 percent, but overall energy consumption increased by approximately 4 percent. Similarly, AmerenUE found that participants in its Residential TOU Pilot who were on the CPP rate with a smart thermostat (the treatment group that consistently shows the highest demand responses to such AMI-supported pricing) increased their usage during the three-hour period after the end of a critical peak period, by 11.6%.[12] Evaluators of the Anaheim (CA) Critical Peak Pricing Experiment found that customers in the treatment group used more energy on the critical peak days than the control group. (Impacts, p. 30). In Ontario, participants increased load during one critical peak period. (Impacts, p. 40).

[11] Karen Herter, Patrick McAuliffe and Arthur Rosenfeld, "An exploratory analysis of California residential customer response to critical peak pricing of electricity," Energy, 32 (2007):25-34 (Exploratory Analysis). Available at www.elsevier.com/locate/energy, p. 26. See also Pat McAuliffe and Arthur Rosenfeld, "Response of Residential Customers to Critical Peak Pricing and Time of Use Rates During the Summer of 2003," California Energy Commission, September 23, 2004.

[12] Research Reports International, "The Impacts of Dynamic Pricing on Electricity Usage (Impacts)," p. 20.

Time-of-Day-Only customers in the Idaho Power pilot increased their consumption during on-peak hours in one of the years of the pilot. (Impacts, p. 38).

Q. As to energy savings, what do you conclude from the Smart Meter pilot results?

A. I conclude that it would not be prudent, at least based on evidence to date, to include estimated energy consumption reductions as an expected result of introducing Smart Metering, TOU rates and Peak Time Rebates.

C. UNCERTAINTY AS TO PERSISTENCE OF DEMAND REDUCTIONS

Q. Are the Company's projections of sustained participation in demand reduction in response to its SEP tariff solid?

A. No. As with other aspects of the Company's assumptions as to demand reductions (and associated benefits), there is no basis for assuming that year in and year out, over the full project horizon, residential customers will participate in the numbers and to the extent projected by BGE. There is thus considerable uncertainty in the Company's estimate of long-term demand reductions from the introduction of SEP pricing.

Q. Are there reasons to question the period of years over which initial SEP load reductions will persist?

A. Yes. Although there have been numerous pilots, and a number of utilities have started full deployment of critical peak tariff designs on an AMI platform, there is not a long track record to point to. Most pilots have run one summer, or at most two. The longest pilot ran 4 years, and for a number of reasons may not provide results transferable to the BGE situation. BGE made its decision to move forward with its AMI and PTR/TOU rates after a one-summer pilot. Full deployments are very new, and as noted above in the

PG&E case, are already producing surprises. For this reason, caution should be exercised in extending results from one or two summers to number of years.

Q. What does the FERC Staff study on achievable demand response say about assumptions for participation in price-based demand response options?

A. The National Assessment for Demand Response Potential, prepared by Dr. Faruqui and others for the FERC staff, notes at p. 62 that only "limited" experience with price-based demand response has been gathered to date. The study acknowledges that "there is very little experience and research to date upon which to base" assumptions as to participation rates. (*Id.*). Based on the experience of Pacific Gas & Electric, the authors concluded that over the long term, 5% would be a conservative estimate of residential participation.

Q. Can you cite an example of a surprising difference between pilot participation (and demand reductions) and the demographics of a real-life AMI-facilitated tariff?

A, Yes, The most recent experience for a dynamic rate for residential customers involves the Pacific Gas & Electric Company SmartRate™ tariff, which is a critical peak pricing tariff that was offered in 2008 to residential customers in the part of the PG&E service territory where AMI meters had been installed. The program was offered through direct mail and roughly eight percent of customers enrolled after a single mailer.[13] Retention rates were estimated based on the percentage of pilot participants who remained on the rate for one year after the pilot was concluded, without the pilot financial incentives and for residential customers in spite of having to pay an incremental meter charge. (*Id.*). The authors acknowledged that at least in one case, the participation rate might be

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[13] Freeman, Sullivan Group, *2008 Ex Post Impact Evaluation for Pacific Gas & Electric Company's SmartRate^tm^ Tariff: Final Report, December 2008*, p. 4. Available at http://www.smartgridnews.com/artman/uploads/1/3_PGE_SmartRate_Ex_Post_Analysis_12-30-08.pdf.

expected to drop after the expiration of the first-year bill protection offered to the C&I customers who remained on the critical peak/TOU rates beyond that first year. (*Id.*).

Q. Are there other reasons to question the length of time over which the estimated load reductions will persist?

A. Yes. If we look back to the efforts of regulators to introduce time-of-use pricing in the 1970's and 1980's, we see a pattern of initial interest in the rates, participation leveling off, and eventual consumer abandonment of the rates. That period in regulatory history was similar to today, in that a number of events came together to focus public attention on the costs (and environmental impacts) of electricity. Many commissions led the electric utilities under their jurisdiction to offer time-of-use rates on a voluntary basis. A number of residential customers signed up for these TOU rates at first. But they did not remain on the rate for the long haul. For example, one major New England utility had 26,500 residential customers on its TOU rate in the mid-80s, but in 2004, only 11 customers remained on the rate.

Q. Are there other examples of customer interest in time-varying rates not persisting over time?

A. Yes. In response to the Western market crisis in 2001, Puget Sound Energy introduced time-of-use rates on a default (opt-out) basis in an effort to curb peak demands. In the first year, almost all residential customers remained on the rate. However, in the next year, when the utility proposed to show the costs of the tariff implementation (e.g., smarter meters) in rates, customers began opting out rapidly, and the public outcry against the rate pushed the Company to withdraw it.[14] Note also that TOU participation

[14] *See also* the response to OPC DR4-17, showing that BGE's "voluntary" TOU rate participation peaked in 1999 and has declined since.

was *not* voluntary for new customers with central air conditioning between 1991 and 1999.

Q. Are you saying that customer "engagement" with the BGE rates will not persist?

A. I am saying that there is great uncertainty as to whether the demand reductions in response to the proposed SEP peak time rebates will persist. Early interest may erode, and possibly quickly.

IV. IMPACTS OF AMI AND SEP ON VULNERABLE CUSTOMERS

Q. Turning now to the impacts of the proposed AMI and SEP rates on vulnerable customers, please explain what you mean by the term "vulnerable."

A. A vulnerable customer in this context would be one who is unable to move load off the critical peak, or at least cannot do so without risk to health and safety.

Q. Please identify the key categories of vulnerable residential customers.

A. Vulnerable customers include low-use customers, low-income customers, disabled customers, and the socially isolated, among others. Low-use customers tend to use only the electricity they need for essentials, such as lighting and refrigeration. Low-income customers are disproportionately low-use, and in general, low-income customers have tended to reduce loads in response to critical peak tariffs at a lower rate than non-low-income customers. Others who may have difficulty shifting and/or reducing their existing peak loads include low-income shift workers, and parents with small children at home. Disabled customers include the roughly 36000 BGE LIHEAP-eligible residential customers who must have electricity to power medical equipment. Along with socially isolated customers, the especially at-risk group also includes customers who are not capable of taking initiatives to respond to peak time rebates.

Q. Is there data specific to Maryland that supports your assertion that low-income customers tend to be low-usage customers?

A. Yes. Exhibit NB-3 presents a table and a chart prepared by the Maryland Department of Human Services, Office of Home Energy Programs, showing the distribution of Electric Universal Service Program (EUSP) grants by usage level. The state agency prepared this as part of its FY 2008 report on the EUSP, under which low-income Marylanders receive grants to help pay for needed electric service. The report was filed in Case No. 8903, as Item 335, Attachment C. As can be seen clearly on the bar chart on page two, the low-income customers receiving EUSP grants cluster at the low end of the range of annual usage levels. The usage levels with the highest numbers of households range between 5000 and 7000 kWh a year (the midpoint, 6000 kWh/year, is 500 kWh per month, below the average for all households).

Q. Are low-income customers the only customers who tend to have lower usage?

A. No. A large percentage of BGE customers have relatively low usage. According to BGE response to OPC DR1-13, about 10% of residential customers use less than or equal to 220 kWh per month. About 20% of residential customers use less than or equal to 380 kWh per month. Finally, almost a third (about 30%) of residential customers use less than or equal to 530 kWh per month. Such customers will have difficulty reducing loads further.

Q. Under the BGE proposal, aside from the time-of-use feature, the SEP tariff will not change current rates. The Company states that customers who do not or cannot reduce load and get the rebates can benefit from the SEP. (Manuel Direct, p. 6). How then do you reason that these customer groups are vulnerable?

A. Customers who cannot reduce critical peak loads must still pay for the AMI system and smart metering investment that is used to provide rebates to other customers. These bill impacts will not be trivial, especially in the case of low-income customers. In addition, in order to economize and take advantage of the rebates, low-income and other vulnerable customers may reduce their usage at critical peaks below levels consistent with health and safety.

Q. Why do you say that low-use customers have difficulty moving load off critical peaks to take advantage of peak time rebates?

A. One analysis of the California pilot showed that low-use customers did not respond to critical peak pricing, or peak time rebates.[15] Another evaluation found some load response on the part of low-use customers, but significantly less than the response of high-use customers.[16] This stands to reason, as such customers are unlikely to have large amounts of discretionary demand that can be moved off critical peaks.

Q. How did low-income high-use customers fare in the California special pricing pilot?

A. According to Herter's analysis, low-income high-use customers experienced adverse bill impacts (higher bills) under the pilot tariffs, even before counting the cost of the advanced metering infrastructure. For reasons that are not yet well enough understood, they did not reduce loads at the critical peak times. While low-income customers may be expected to try to reduce their bills by taking advantage of the SEP rate, many will be unable to do so and will not receive rebates.

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[15] Karen Herter, "Residential implementation of critical-peak pricing of electricity," *Energy Policy* 35 (2007): 2121-2130 ("Herter"). Available at www.elsevier.com/locate/enpol.

[16] Charles River Associates, *Impact Evaluation of the California Statewide Pricing Pilot*, March 16, 2005 ("CRA"). Available at http://www.energy.ca.gov/demandresponse/documents/index.html#group3.

Q. What should be done to address the problems facing vulnerable customers under critical peak tariffs?

A. The most important step, short of not going ahead with the deployment of the AMI at all, is to keep the costs of the deployment down as much as possible. This will help mitigate the bill impacts on customers who cannot take advantage of the rebates. Requiring a robust benefit/cost ratio will help to keep the pressure on deployment costs. Holding customers harmless from (a) excessive spending on deployment, (b) insufficient savings to offset deployment costs for all customers, or (c) both, would also help protect customers who cannot participate directly in the Peak Time Rebate.

Q. Are there other ways to mitigate the burdens that SEP will place on vulnerable customers who cannot take advantage of SEP rebates?

A. Yes, smart grid costs should be recovered on a volumetric rather than fixed basis. In this way, low-use customers who cannot take advantage of SEP tariff benefits will not be as burdened with costs of the new system as they would be under fixed charge cost recovery. For more discussion of volumetric cost recovery, please refer to the testimony of J. Richard Hornby on this topic.

Q. Are there other steps the Company can take in an effort to mitigate the adverse impacts on vulnerable customers?

A. Yes. Utilities generally should also do in-depth research to identify customers who are vulnerable to the adverse effects of SEP pricing and AMI costs, and understand why they have difficulty moving usage off critical peaks (or do reduce loads but at risk to their own health and safety). Based on this knowledge, and working with key stakeholders such as government agencies, community groups, and others the utility can develop targeted outreach to such customers to assist them in understanding the tariff, taking advantage of rebates where it is reasonable, and connecting such customers with resources that can help them manage their usage and bills most effectively, given their circumstances. I should caution, however, that such efforts are unlikely to identify and protect all vulnerable customers. They should not be seen as a solution for the problems that deployment of advanced metering will bring for such customers.

V. MANDATORY TIME OF USE COMPONENT OF SEP

Q. Please discuss the Company's proposal that the SEP rate include mandatory time-of-use rates.

A. Imposing mandatory time-of-use rates on all residential customers should not be approved in this docket. It should be allowed, if at all, only after the kind of thorough investigation of cost allocations and rate designs that takes place in a base rate case.

Q. What are some reasons that TOU rates should not be approved in this docket?

A. The change from a constant per kWh rate for generation costs to a time-varying rate will have the effect of significantly reallocating the cost burdens among residential customers. Higher on-peak rates will put burdens on customers who cannot move usage off those peak periods, including most low-use customers of all incomes. As noted above, almost one third of BGE residential customers have monthly usage below 530 kWh, and as many as 20% have usage under 380 kWh per month. About 10% have usage under 220 kWh per month. At these low levels, one cannot reasonably expect customers to cut usage even further. But unlike critical peak rebates, the proposed TOU rates will intentionally raise rates on customers who cannot move their usage. Customers will be right to experience this as a stick, and not a carrot.

Q. Above you noted that low-income customers tend to be low-use customers. Why then should the Commission be concerned about high-use low-income customers?

A. Exhibit NB-3, showing the predominance of low-users among EUSP recipients, also shows that there are a significant number of low-income customers who have very high usage. For example, of the roughly 100,000 recipients of EUSP grants, about 10,000 such households have usage above 1700 kWh per month. Bills for such customers are already unmanageable, and higher bills associated with the imposition of TOU rates will make the burden greater.

Q. Are potential difficulties with a switch to TOU rates a problem only for low-income residential customers?

A. No. Residential customers of all income levels can have similar problems if they cannot move their usage off peak.

Q. Are there other reasons not to approve the BGE TOU proposal at this time?

A. Yes. The Company presents no evidence in this docket of the likely customer response to TOU pricing, nor the bill impacts on various subgroups of residential customers. The SEP pilot tested a TOU rate design with the critical peak pricing design, but not with either version of the peak time rebate proposal that is proposed as the demand-response tariff in this docket. This absence is important, because it leaves the Commission unable to predict the impact of the proposed PTR/TOU rates. One can speculate based on assumptions about customer response to time-differentiated price signals. But such speculation is not always borne out in reality.

Q. What, if any, analysis did BGE do to determine whether to require that TOU rates be mandatory, as opposed to voluntary, for residential customers?

A. BGE states that it did not prepare any written analysis of the advantages and disadvantages of offering TOU rates on a voluntary basis. (Response to OPC DR2-7).

BGE "feels that rates which better reflect the true costs of production are appropriate...." (*Id.*). Without analysis or support, BGE goes on to assert that TOU rates "will provide long-term benefits to all customers." However, BGE has not attempted to quantify such benefits. BGE also states that it has not conducted any customer surveys to about implementing a TOU tariff. (Response to OPC DR2-21).

Q. Are there many BGE residential customers who have chosen to take service under TOU rates?

A. No. Only about 6% of residential customers are on TOU rates at present. (Response to OPC DR2-10). Participation in the residential rate peaked in 1999, and has dropped 50% since then. (Response to OPC DR4-17). It is probable that the increase in numbers of residential customers taking service under this rate between 1994 and 1999 is attributable, at least in part, to the fact that from 1991 to 1999, all new single-family residential premises with central air conditioning were automatically TOU customers. (Response to OPC DR2-21).

Q. Are there reasons to question the efficacy of TOU rates in producing flatter load shapes?

A. Yes. Looking at recent pilot experience, it is not possible to conclusively determine the impacts of TOU rates on usage patterns. For example, according to the evaluation of the California Statewide Pricing Pilot by Charles River Associates, in the second year of the pilot the TOU rate impact almost completely disappeared.[17] In addition, the small sample size and other factors in the California SPP made it difficult to isolate the impact of the TOU component of the PTR and CPP rates that were piloted.

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[17] Charles River Associates, *Impact Evaluation of the California Statewide Pricing Pilot*, March 16, 2005 (CRA), p. 8. Available at http://www.energy.ca.gov/demandresponse/documents/index.html#group3.

Q. Are there other reasons that the Commission should defer consideration of mandatory TOU rates to a proceeding in which the Company can make the proper presentation?

A. Yes. Elementary principles of ratemaking such as rate continuity, not to mention public understanding and acceptance, require that such a proposal be vetted in a proceeding that contains a direct focus on the TOU question.

Q. Have Commissions tried to institute residential TOU rates in the past?

A. Yes. I remember in the 1980s the efforts of Commissions on whose staff I served at the time to impose mandatory time-varying pricing. We pointed to just the kinds of arguments made by BGE in this docket – a concern for accurate price signals, among other reasons. More than once I saw these initiatives repulsed by legislative action. The rates were not popular among the public, and their elected representatives made certain the Commissions understood this.

Q. What do you recommend?

A. I recommend that the Commission allow BGE to offer TOU on voluntary basis, but not on a mandatory basis as proposed.

VI. IT STANDARDS NOT YET IN PLACE FOR SMART GRID TECHNOLOGIES

Q. Please now turn to the question of the dynamic nature of information technology in the advanced metering industry. To what extent has the industry settled down, and developed protocols and standards of general applicability?

A. Advanced metering infrastructure is still experiencing rapid technological development. Vendors are promoting their solutions to technical problems, while industry groups are meeting with government facilitation in an attempt to establish common standards, especially in key areas such as cyber-security and interoperability.

Q. Please explain what you mean by cyber-security.

A. Cyber-security refers to the security of the information passing over the communications networks of the smart grid, and to the security of controls over system components, such as circuit breakers and other components of the system essential to the functioning of the grid. It also refers to the security of customer data (privacy), discussed below under Consumer Protection issues. Security may be compromised by equipment or operational faults, as well as intentional breaches by hackers, and unauthorized access to data and controls.

Q. What is "inter-operability"?

A. Interoperability refers to the ability of any given component of the smart grid to communicate with the other components to which it is connected, passing data, and commands, smoothly, quickly and accurately back and forth. Protocols for data transfer must be compatible, if not identical, for components to be interoperable.

Q. Does the interconnection of elements of the grid under AMI create openings for breaches in the cyber security of the grid?

A. Yes. AMI is essentially a huge and complicated communications and data processing network, or more accurately, a network of networks. Sensitive information will pass over the communications networks set up to administer dynamic pricing and to manage grid functions. New and remotely-programmable controls of various grid components will be installed. Communications systems such as enterprise networks for core business data processing, network access and backhaul, neighborhood or local area networks, and home area networks, will be created and interconnected. The systems will be tied together more than ever. They will be more complex than ever. Interoperability, size, complexity and novelty provide opportunities for unauthorized data and control access.

Q. In what ways will the advanced metering and smart grid infrastructure be vulnerable to cyber-attacks?

A. There are a number of cyber-security vulnerabilities of AMIs that have been identified so far, and as with all complex information technology solutions, there are vulnerabilities that have not yet been, and cannot reasonably be, foreseen. Among the known vulnerabilities are (a) physical tampering with elements of the network, (b) eavesdropping in on or jamming wireless signals that connect Smart Meters to neighborhood data collection points, (c) password compromises, (d) unauthorized data collection, (e) suboptimal priority for data transfer over public (e.g. cellular) networks, (f) lack of control of internet paths and reliability, and (g) denial-of-service attacks (in which an unauthorized user generates a huge number of messages to go over the system, which overloads the communications system and triggers interruptions of the system).

Q. Are these vulnerabilities theoretical, or have important systems been compromised in similar ways in reality?

A. A cyber security expert from SAIC, a firm offering cyber security services, recently noted to the Kansas Corporation Commission the following examples of cyber security breaches:[18]

- 1998 Telephone switch hack closes an airport
- 2000 Gazprom central control is hacked
- 2000 Disgruntled water-treatment plant employee in Australia rigs controls to release sewage
- 2001 Hackers protesting US/China conflict enter US electric power systems
- 2003 Worm shuts systems down at Davis-Besse nuclear plant.

[18] Gib Sorebo, *Smart Grid Security*, a presentation to the Kansas Corporation Commission, September 18, 2009.

- 2006 Zotob virus shuts down GM Holden Ltd car manufacturing plant
- 2007 Aurora demonstration shows a remote hacker can cause physical harm to a generator.

Other evidence of grid vulnerability was reported in the Wall Street Journal of April 8, 2009, citing the fact that an electricity grid in the United States had been penetrated by spies, possibly Russian or Chinese. The report, quoting industry and government sources, also noted that hackers had penetrated electrical systems abroad and tried to extort money to avert damage. (*Id.*).

Q. Are there other examples of cyber security breaches in the electric grid of today?

A. Yes. In 2007, a disgruntled employee of the California ISO allegedly tried to access the system's emergency power cut-off, and in the process shut down much of the ISO's data center over a weekend. Luckily the only damage, besides the physical damage to equipment, was that CAISO could not get access to the energy trading market. Upon arresting him, the FBI warned that, had the employee carried out this attack during normal business hours, "electric consumers in the Western United States would have experienced disruptions in their electrical supply".

Q. Have there been official complaints about lax security in the grid today?

A. Yes. In May, 2008, the General Accountability Office (GAO) released a report identifying numerous vulnerabilities at the Tennessee Valley Authority (TVA) that put the nation's biggest public power company at risk of cyber attacks.[19] Among other things, according to the GAO, the TVA used poorly implemented passwords, relied on lax logging practices, failed to install key software patches, and had firewalls that were

[19] Available at http://www.gao.gov/new.items/d08526.pdf.

improperly configured or were bypassed. A less formal but equally sobering report, published on the on-line journal "Security" quotes a "hacker" hired by a utility to explore vulnerabilities in one manufacturer's meters.[20] The vulnerabilities, this security consultant said, are ripe for abuse. The consultant asserted that the new meters needed to make the smart grid work are "built on buggy software that's easily hacked." At the Black Hat ("benign hackers") convention in Las Vegas this summer, this senior security consultant demonstrated a "worm" that he had created that could infect a particular brand of smart meter, and move back and forth between the meters at homes and businesses in a smart grid network. The consultant said it would be possible to program the worm to infect other manufacturers' smart meters.

Q. Please give an example of a plausible but intolerable breach of cyber-security under the smart grid.

A. As the "black hat" security consultant noted, the inclusion in the meter of a module permitting a meter to be turned off remotely through signals sent from a central location creates a risk that a hacker could get into the control system for meters, and remotely disconnect power to hundreds of thousands of customers.

Q. What is one of the weakest links in maintaining cyber security of any IT functions, such as those in the interconnected smart grid?

A. It is well known that human error or failure to maintain secure practices is a weak link in cyber security. A frequently cited example of this phenomenon is employees' failure to observe rules for security of passcodes, frequency of passcode changes, and the like.

Q. The electric industry is aware of the importance of cyber security. Would they not be expected to exercise heightened vigilance to prevent human errors from compromising security?

[20] Available at http://www.theregister.co.uk/2009/06/12/smart_grid_security_risks/.

A. While employees of electric utilities may be more aware of the importance of cyber security than those in other industries, they are still human beings, and subject to making errors. A recent allusion to this reality came in an April 7, 2009, letter to industry stakeholders from Michael Asante, the Chief Security Officer of the North American Electric Reliability Corporation (NERC), the organization charged by the Federal Energy Regulatory Commission (FERC) with overseeing industry efforts to maintain reliability (including the prevention of cyber-compromises). In his letter, reporting on the results of a 2008 self-certification compliance survey for NERC Reliability Standards CIP-002-1 – Critical Cyber Asset Identification, Mr. Asante noted that some industry members failed to identify their assets as "Critical" and thus falling under the Standard.

Q. Does the letter to industry stakeholders from NERC's Chief Security Officer contain further insight into the risks of a breach of grid cyber security?

A. Yes. Mr. Asante observed that, as we consider cyber security, "a host of new considerations arise" for the electric system:

> Rather than considering the unexpected failure of a digital protection and control device within a substation, for example, system planners and operators will need to consider the potential for the simultaneous manipulation of all devices in the substation, or, worse yet, across multiple substations. I have intentionally used the word "manipulate" here, as it is very important to consider the misuse, not just loss or denial, of a cyber asset and the resulting consequences...Taking this one step further, we, as an industry, must also consider the effect that the loss of that substation, or an attack resulting in the concurrent loss of multiple facilities, or its malicious operation, could have on the generation connected to it.

Mr. Asante specifically addresses the unique problems that will arise because of the interconnected-ness that characterizes the smart grid:

> One of the more significant elements of a cyber threat, contributing to the uniqueness of cyber risk, is the cross-cutting and horizontal nature of networked technology that provides the means for an intelligent cyber attacker to impact multiple systems at once, and from a distance....This is

why protection planning requires additional, new thinking on top of sound operating and planning analysis.

Q. Are there other reasons to be concerned about the security of IT programs and networks, such as the Smart Grid?

A. The sheer complexity of the interconnected IT applications for a smart grid makes it almost impossible for system engineers to anticipate, and thus to provide protections from, all possible problems that might occur - what we refer to as "glitches" or "bugs" when talking about our own personal computers. As a result, one must anticipate that some bugs will be present, and at some time will cause some form of system failure.

Q. What has Commerce Secretary Locke said about the importance of cyber security?

A. Announcing the release of the draft Roadmap in late September, Secretary Locke commented that cyber security is an area in which:

> ...we need to take the time to do it right because security must be designed deliberately into the foundation of the Smart Grid. It cannot be added on later, and it must be uniform. Having 48 of 50 states implement security specifications will not suffice. The Smart Grid gets its "smarts" from sophisticated computer systems—but that also provides vulnerability.

Q. How, if at all, can an industry address cyber security risks?

A. Utilities must (continue to) participate actively in the various stakeholder processes addressing the multitude of interoperability and security standards being developed for the smart grid. IT managers must not only run as many simulations of real life use of their new systems as they can foresee before they allow them to go operational, to test the system's ability to handle foreseeable problems, but the utilities must also be vigilant once the system is in place, identify problems as they occur, and develop and install software upgrades to "patch" the problem. We are familiar with Microsoft security upgrades – their engineers spend a great deal of time reacting to and trying to overcome bugs in the software not found until after deployment. Utilities and their contractors will have to do the same.

Q. How can utilities deal with the "human problem"?

A. Good security controls are just a beginning in an effort to reduce human error, or malicious tampering. Training of staff must be initiated and refreshed frequently. The importance of cyber security must be stressed often, and observed by management.

Q. Will such diligence prevent a loss of service associated with a cyber attack?

A. Not absolutely. One prominent school of thought in cyber security is that any given software can be compromised by the persistent and knowledgeable hacker. Consider that for years we have planned our generation and transmission "iron in the ground" capacity so as to have no more than one day's outage in ten years. We will now have to expect cyber security breaches, from time to time, and the resulting outages or other damages despite our best efforts.

Q. Are there standards in place for utilities to follow to minimize threats to the cyber security of the smart grid, and to assure the smooth interoperability of its various parts?

A. There are some standards in place for some aspects of the smart grid.

Q. Please outline the status of efforts to develop industry-wide standards.

A. Under the Energy Independence and Security Act (EISA) of 2007, the National Institute of Standards and Technology is taking the lead in promoting comprehensive standards in the area of interoperability.[21] As part of this effort, NIST convened the Cyber Security

[21] Available at http://www.nist.gov/smartgrid/.

Coordinating Task Group, and is promoting the development and implementation of associated cyber security standards. As yet, it is not possible to be sure when NIST and the entities developing the standards themselves (i.e. IEEE, NERC) will be able to complete their work. NIST has issued a "roadmap" for the work needed to get from here to standards (the draft NIST Framework and Roadmap for Smart Grid Interoperability Standards on September 24, 2009), and has set timing goals for release of standards in the most important topic areas by the end of 2010. The roadmap itself, however, is not a set of standards. And the timing goals for standard release are very ambitious.

Q. Are there reasons to expect that important smart grid standards will not be in place before the end of 2010, if not later?

A. Yes. NIST and industry members are pushing hard to complete the primary standards work. But NIST cautions that "several hundred standards that are identified or developed over the span of several years may be required to achieve secure, end-to-end interoperability across a fully implemented Smart Grid."[22] The NIST roadmap uses qualifying language to describe its expectations for full standard release by the end of 2010, saying for example that its priority action plan will address "many" (as opposed to "all") of the needed modification to standards already denoted as "consensus" standards. (Roadmap, p. 38). In prepared comments released with the Roadmap, Commerce Secretary Locke likened the Roadmap to a designer's first detailed drawing of a complex structure. "It presents a high-level conceptual model to ensure that everyone is on the

[22] Available at http://www.nist.gov/smartgrid/standards.html (Roadmap).

[24] Available at http://www.nist.gov/public_affairs/releases/smartgrid_092409.html.

same page before moving forward to develop more detailed, formal Smart Grid architectures."[24] Similarly, as NIST describes the challenge on its web page:

> The task is akin to developing standards for the next-generation telecommunications network. This effort has spanned many years, continues to evolve, and involves dozens of standards development organizations. Also, like the telecom network, the Smart Grid is almost entirely owned and operated by industry. Therefore, Smart Grid interoperability and cybersecurity standards must reflect industry consensus, with active participation, and where required, leadership and coordination by government. (*Id.*).

Q. Are there other technology issues facing BGE and its regulators in their choice of Smart Grid approaches?

A. Yes. The rapid development of not only the technologies but also of the rate designs and related AMI functionalities makes the job of the system planner very complicated. Best practices require that the designers of the hardware, software and communications networks engineer the system to a well-defined end-state of functionalities for the system (use cases). Exactly what information does who need for what purpose at what time? Utilities such as PG&E and Oncor have experienced difficulties when they chose technologies that turned out not to have certain desired functionalities (in these cases, desired by the regulators). PG&E customers are paying incremental costs for functions that conceivably could have been integrated less expensively had they started with those specifications in mind before designing and bidding out the metering project. Oncor finds itself trying to recover the costs of a metering choice that was rendered obsolete when the state of Texas determined that utilities must provide different functionalities in their smart meters. Inasmuch as proponents of the smart grid point to the possibility of benefits not yet imagined, the continuing evolution of the smart grid presents challenges to system planners, especially at this early stage in its development.

Q. Are there financial risks of moving ahead before the industry and government have settled on standards for cyber security and interoperability?

A. Yes. The fact that some technical standards are still being finalized creates a risk that additional costs may incurred if some of the technologies deployed now prove to be incompatible with the standards that are ultimately established in the future.

Q. Have policy leaders on smart grid issues recognized the risk facing pioneers and early adopters?

A. Yes. Commerce Secretary Gary Locke spoke to these risks in his presentation to the GridWeek conference in Washington on September 24, 2009. As he said on regarding the need for cyber security and interoperability standards:

> These standards are needed immediately to ensure we don't prematurely render otherwise viable products obsolete. For example, we don't want smart grid meters—the key communication device that links utilities with consumers—to suffer from "beta versus VHS" rivalries.[25]

Q. Can the risks of moving ahead before technological standards are in place be eliminated by contractual provisions with vendors?

A. Not fully.

Q. Given the risks of moving ahead before standards are settled, and the difficulty of using contract provisions to protect consumers, should BGE go ahead at this time with its proposed deployment?

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[25] Available at http://www.commerce.gov/NewsRoom/SecretarySpeeches/PROD01_008443.

A. It would be prudent to wait a year or more and see if the ambitious standards-development schedule has been successful. In such a case, BGE would not have to take the risks of an early adopter (much less a pioneer). If the utility does not want to wait, the utility should hold the customers harmless from the potential disruption and cost of having to redesign and retrofit their smart grid system to take account of changed requirements.

VII. CONSUMER PROTECTION

Q. Please turn now to the issues of risks to consumer rights and protections posed by the universal deployment of an advanced metering infrastructure.

A. There are two categories of risks to consumer rights and protections that I will discuss. The first is the threat to the privacy of customer data, and the second is the threat of unfair and unnecessary disconnections as a result of the use of smart metering for remote disconnection, prepayment metering and service limiting.

A. PRIVACY

Q. Please describe the privacy issues that arise in the case of the smart grid and advanced metering infrastructure.

A. As noted above, the interconnectedness of the smart grid makes data carried over the communications networks vulnerable to improper access by unauthorized persons. The advanced metering infrastructure will at a minimum capture and store data on all consumers' hourly usage. This information could be used to estimate which customers have which types of appliances and equipment at home. It could be used to estimate whether a customer is home, weekdays, or for several weeks during vacation. If customers install Home Area Networks (HAN) and tie their appliances and computer in to the network, that network could be hacked, and specific information about electricity usage could be obtained. To the extent all these systems are hooked into the customer's internet connection, the customer's computers could be at risk, as well.

Q. If no HAN were installed, and hackers could only get usage data, why would or should customers care? This is not the type of data customers usually consider private, is it?

A. Intrusions into privacy raise major issues for customers. One cannot assume that what a utility consultant might find merely interesting would not trigger a concern among consumers about breaches of privacy. Media coverage of smart grid deployment is already causing some consumers to voice concerns over privacy if the utility collects usage data.[26] The success of any AMI deployment will depend on the long-term ability to protect the privacy of customer information.

Q. How does NIST characterize the problem of safeguarding consumer data privacy in the smart grid era?

A. In the draft Roadmap released September 24, 2009, NIST noted that the major benefit provided by the Smart Grid, the ability to get richer data to and from customer meters and other electric devices, "is also its Achilles' heel from a privacy viewpoint." (Roadmap, p. 84). NIST went on to say that privacy advocates have raised serious concerns about the type and amount of billing and usage information flowing through the various

[26] *See*, for example, the critical posting by Bob Sullivan, October 9, 2009, "What will talking power meters say about you?" together with comments from concerned readers, about the Pepco Maryland smart grid deployment, available at http://redtape.msnbc.com/.

components of the Smart Grid, information "…that could provide a detailed time-line of activities occurring inside the home."

Q. How is NIST handling privacy concerns?

A. NIST has set up a task force to coordinate efforts to identify privacy issues and develop ways to address them.

Q. What are some of the problems NIST has identified in dealing with consumer privacy concerns?

A. In a NIST draft report on Smart Grid Cyber Security Strategy and Requirements,[27] the authors stated that a major problem facing the smart grid today is the lack of coordination among different government jurisdictions with responsibility for protecting consumer privacy:

> Most states have general laws in place regarding privacy protections. However, these laws are most often not specific to the electric utility industry. Furthermore, enforcement of state privacy related laws is often delegated to agencies other than public utility commissions, who have regulatory responsibility for electric utilities. Research indicates that, in general, state utility commissions currently lack formal privacy policies or standards related to the Smart Grid. Some individual utility implementations of the Smart Grid are currently at an early stage, while others are more fully developed. Utilities at an early stage of implementation may have not yet documented or implemented privacy policies, standards, or procedures for the data collected throughout the Smart Grid. Comprehensive and consistent

[27] NIST IR 7628, released in September 2009 (NIST Cyber Security Draft 7268), p. 8. Available at http://csrc.nist.gov/publications/drafts/nistir-7628/draft-nistir-7628.pdf.

> definitions of personally identifiable information (PII) do not typically exist at state utility commissions, at FERC, or within the utility industry. The lack of consistent and comprehensive privacy policies, standards, and supporting procedures throughout the states, government agencies, utility companies, and supporting entities that will be involved with Smart Grid management and information collection and use creates a privacy risk that needs to be addressed.[28]

Q. What does the NIST draft report on cyber security recommend about protecting privacy of PII?

A. The NIST report authors set out ten high-level principles for which specific standards must be developed in the areas of (1) Management, Accountability and Training, (2) Notice and Purpose for PII Use, (3) Choice & Consent to use PII, Collection of PII, (4) Use and Retention of PII, (5) Individual Access, (6) Disclosure and Limiting Use of PII, (7) Security and Safeguards, (8) Accuracy and Quality of PII, (9) Openness, and (10) Monitoring and Challenging Compliance. The principles are set out in my Exhibit NB-4. The NIST draft report recommends that standards be developed to address the privacy risks it has identified.[29]

Q. Given the state of uncertainty and lack of standards for protecting personally identifiable information in the smart grid, how can customers' rights to privacy be protected?

A. The smart grid should not be put in place before these privacy principles are translated to specific norms, embraced by the industry, and properly enforced. Given the rudimentary and jumbled state of smart grid privacy standards at this time, it will take some time (likely more than one year) to develop a good starting point for protecting the data that is

[28] NIST Cyber Security Draft 7628, p. 8.

[29] *Id.* at 9-10.

to be collected. Even then, as with the general problem of cyber security, it may not be possible to stop all unauthorized access to customers' data. The public deserves to be educated about the risks that come along with the benefits of the emerging smart grid. This is not only good policy from the consumer perspective, it will be essential to attaining widespread public support for smart grid deployment.

B. RISKS OF UNNECESSARY AND UNFAIR DISCONNECTIONS

Q. How does implementation of smart grid technology increase the risks of unnecessary and unfair disconnections of residential households?

A. Smart meters can be used to introduce three practices, each of which pose risks to certain customers of unnecessary or unfair disconnections. First, smart meters can be installed with modules that permit the utility to disconnect the power to a customer's house remotely, by flicking a switch at the utility's offices, without sending a technician to disconnect the meter. Second, although BGE has not proposed to implement pre-payment metering or service limiters, smart metering provides a relatively inexpensive foundation for implementing pre-payment metering and service limiters in the future.

Q. How does remote disconnection increase risks of unnecessary and unfair disconnection?

A. Today, to cut off power to a customer, the utility sends a technician to the premises to "pull the meter." This process provides an opportunity to avert disconnection in the case of a payment-troubled household threatened with disconnection for non-payment. When a technician comes and pulls the meter, the customer gets final notice of the impending shut-off. Also, the customer has an opportunity to pay any delinquencies on the bill, and avert shut-off. This “last knock” notice and opportunity help prevent unnecessary shut-offs by providing an opportunity for the customer to fix the problem that led to the disconnection decision. The in-person disconnection also provides an opportunity to work out problems with the utility. Remote disconnection eliminates this “last knock” notice to the customer, and final opportunity to resolve bill issues.

Q. Are there circumstances where remote disconnection makes sense and does not threatened consumers’ access to utility service?

A. Yes. In the event of voluntary terminations, such as at move-in and move-out of premises, remote disconnection would not threaten consumer rights. Further, if the utility were to send out an employee to make the “last knock” before a remote termination, the customer’s rights could be preserved. Such an employee would not need to be an electrician, or bring a service truck to the location when making the last knock visit, but could presumably call in the results of the visit to the control center. The employee would need to be able to take payments on account, and work out payment arrangements or refer the customer in real time to a customer service representative authorized to make such arrangements and avert the disconnection. In this way, savings from avoiding the meter pull could be realized without undermining access to service.

Q. Doesn’t BGE have permission today not to accept payment at a “last knock” visit?

A. I cannot comment on the legal status of BGE’s longstanding practice of accepting payment at a “last knock” visit. BGE has not stopped this practice, and continues to allow customers to make payments during such visits. I can also say that protecting maintenance of a necessary service is a better policy than remotely disconnecting payment-troubled customers, and denying them a final opportunity to make payment or payment arrangements.

Q. But isn't the threat of swift and sure disconnection needed to induce customers to pay their bills in full and in time? Is there not a moral hazard in providing the protections you describe?

A. No. The number of customers for whom certain disconnection is needed, and useful, in producing timely and full payment is smaller than may be imagined. BGE many years ago did a survey of its payment-troubled customers, and found that a disproportionate number of them did not pay on time and in full because they were low-income, not because they were taking advantage of a grace period before disconnection. Those results were similar to a survey done by a Wisconsin combined gas/electric utility in the 1990s. In that study, the utility found that only 12% of delinquent customers had the money and could have paid, but chose not to do so. Indeed, that utility began an "early identification" service to reach out to the payment-troubled customers who had money management problems or who were low-income. In this way, the utility sought to maintain a positive relationship with such member of its service area community, and solicit better payment patterns from low-income customers. Disconnections were down as a result of new state policies, but bad debt did not increase, on account of the early identification outreach, and the information, referral, and payment plan negotiations that are part of such an effort. In such a context, dropping "last knock" visits and payment arrangement opportunities would be a step in the wrong direction.

Q. How does prepayment metering risk unfair and unnecessary disconnections?

A. Under a prepayment metering approach, power will flow only so long as the customer has paid in advance. The customer puts money in the meter to get power, typically through a smart card, which operates much like a prepaid wireless or long-distance card. If the smart card amount is used up, and the card is not "recharged," the customer's service will be disconnected. In practice, the result is that customers are disconnected without the advance notice and consumer protections afforded by regulation and utility practice.

Q. Is there evidence that customers end up shut off from service as you suggest?

A. Yes. The French distribution utility, Electricité de France (EDF), at one time required delinquent customers to accept prepayment metering as a condition of continuing to receive service. They abandoned that practice after their sociologist's research found that low-income and other vulnerable customers were cutting themselves off, inadvertently, when they were unable to charge up their prepayment smart cards. Because the disconnection was automatic, and "remote" (at least from the awareness of the utility), there was no advance notice, nor an opportunity to work with the customer to arrange for help paying the bill, make payment arrangements, or otherwise manage the customer's payment difficulties in a humane and practical way. As a result of this research, EDF changed its policy, and does not allow such vulnerable customers to take service under a prepayment arrangement.

Q. Are there other recent examples of consumer protection violations with the use of pre-paid metering of electricity?

A. Yes. A recent investigative news report from Texas (where deregulated electricity commodity vendors can offer service on a pre-paid only basis) tells of vulnerable pre-paid electricity customers being cut off without notice.[30] Families with children have had

[30] Steve McGonigle and Ed Timms, "Cutoffs, complaints abound with Texas' prepaid electric providers," Dallas Morning News, October 4, 2009.

to abandon their homes. A paraplegic who requires air conditioning to maintain a safe body temperature lost his electricity on days when the temperature exceeded 100 degrees. A heart failure patient who needed power for an oxygen machine was cut off twice in one summer.

Q. Has another public service commission reviewed the fairness of prepayment metering in connection with advanced metering deployment?

A. Yes. The Massachusetts Department of Public Utilities recently dismissed the smart grid filing of a major electric distribution utility in the state because it proposed to pilot prepayment metering among low income customers. The Commission found that such metering would violate regulations promulgated to ensure safe and reasonable access to service, including advance notice of pending disconnection and an opportunity to dispute the bill.

Q. Please describe how service limiters present risks of unfair and unnecessary disconnection.

A. Service limiters are just what they sound like: devices that cause a circuit breaker in the meter to trip open if the amount of electricity used exceeds a preset limit. Like a circuit breaker, they can be reset under certain circumstances. In essence they put a customer at risk of the power going off without advance notice if usage happens to exceed the limit. As in the case of prepayment metering, tripping the service limiter causes a disconnection without notice and an opportunity to take care of the bill.

Q. Can you give an example of a service limiter causing an unfair and unnecessary disconnection?

A. Yes. This past winter, a 90-year old gentleman from a town in Michigan froze to death because a service limiter was put on his meter. He had fallen behind in his bill, and the (municipal) utility had a policy of putting on service limiters until bills were paid up.

The fellow was found dead in his freezing cold house. On the kitchen table was found money sufficient to pay the bill. The fellow never got a chance to pay his bill before disconnection – he may not have been able to get to the meter to reset it, he may not have understood that he could do that, or how. But in any event, he suffered a painful death because the service limiter tripped in the middle of winter.

Q. How do you recommend the Commission prevent these risks of unnecessary and unfair termination of service?

A. I recommend that the Commission make findings to the effect that these three uses of the smart metering installation pose risks of unnecessary and unfair loss of electric service, and that the Commission will not accept them as an element of smart metering deployment. Utilities would retain the right to petition for a change in the policies, practices and regulations, but consideration of such changes should take place only in proceedings that are focused enough on the issue to permit a full exploration of the facts and the ramifications.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Q. What do you conclude based on your review of certain issue raised in this docket?

A. My conclusions are as follows:

- Estimates of demand response to SEP rates are subject to uncertainty, and likely overstated. Participation rates are subject to uncertainty. Estimates of energy savings from SEP are subject to great uncertainty. Assumptions as to persistence or sustainability of demand response are subject to uncertainty.
- Implementation of dynamic pricing puts vulnerable customers at risk.

- The Company's proposal to implement mandatory residential TOU rates is premature, and unsupported in this docket.
- Standards and protocols necessary to design and operate an advanced metering infrastructure are still in a state of flux, and investments made now, before the standards have been more settled, are at risk of obsolescence.
- Privacy concerns of customers about their usage and other personal information are real, and it is not yet clear that they can be addressed in a meaningful way. Deployment should not proceed until these concerns are addressed to the Commission's satisfaction.
- Installation of advanced meters will open the door to practices such as remote involuntary disconnection, prepayment metering, and use of service limiters, all of which threaten customer access to service. The Commission should make clear that consumer protections will be maintained and enforced, even if technology threatening such protections is ultimately installed.

Q. What do you recommend to address the problems you have outlined in your testimony?

A.

- I recommend that cost-benefit evaluations of the proposed smart grid installation take into account the uncertainty as the level of demand and energy reduction, and the persistence of such reductions, in response to the smart metering program, and if the utility wishes to proceed on the basis of the estimates used in this filing, it should do so at its own economic risk,
- steps should be taken to identify potentially vulnerable customers and develop and provide means of mitigating the risks they face as a result of the

deployment of smart metering and SEP pricing, including use of volumetric rates, rather than fixed per customer rates, to recover the cost of the smart grid installations,

- the mandatory TOU component of SEP should not be considered in this docket, and should only be considered in a rate case or similar proceeding where the full implications of such a rate design change can be examined, given the changes it would make to cost allocations within the residential class.
- BGE be required to demonstrate that comprehensive and effective cyber security and interoperability standards, and strong standards enforcement mechanisms, are in place before it proceeds with deployment of that advanced metering infrastructure,
- BGE be required to demonstrate that privacy standards, and strong enforcement mechanisms, are in place before proceeding with the deployment of advanced metering and related infrastructure and
- the Commission determine that as a policy matter, smart grid investments will not be used to institute eliminate "last knock" and other consumer protections against remote disconnection for non-payment, to institute prepayment metering and service limiters, or otherwise to undermine existing customer rights and protections.

Q. Does this conclude your testimony?

A. Yes.