ATTACHMENT F

BEFORE THE MISSISSIPPI PUBLIC SERVICE COMMISSION

ENTERGY MISSISSIPPI, INC.	IN RE: APPLICATION FOR APPROVAL OF ADVANCED METERING INFRASTRUCTURE AND RELATED MODERNIZATION IMPROVEMENTS
EC-123-0082-00	

DIRECT TESTIMONY

OF

AHMAD FARUQUI, PH.D.

PRINCIPAL, THE BRATTLE GROUP

ON BEHALF OF

ENTERGY MISSISSIPPI, INC.

NOVEMBER 2016

I. QUALIFICATIONS

Q. PLEASE STATE YOUR NAME, TITLE, AND BUSINESS ADDRESS.

A. My name is Ahmad Faruqui. I am a Principal with The Brattle Group. My business address is 201 Mission Street, Suite 2800, San Francisco, California 94105.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING?

A. I am testifying before the Mississippi Public Service Commission ("MPSC" or the "Commission") on behalf of Entergy Mississippi, Inc. ("EMI," "Entergy Mississippi," or the "Company").

Q. PLEASE BRIEFLY DESCRIBE YOUR EDUCATIONAL, PROFESSIONAL, AND BUSINESS EXPERIENCE.

A. I have 40 years of academic, consulting and research experience as an energy economist. During my career, I have advised 135 clients in the energy industry, including utilities, regulatory commissions, government agencies, transmission system operators, private energy companies, equipment manufacturers, and information technology ("IT") companies. Besides the U.S., my clients have been located in Australia, Canada, Chile, Egypt, Hong Kong, Jamaica, Philippines, Saudi Arabia, South Africa, and Vietnam. I have advised them on a wide range of issues including cost-benefit analysis of advanced metering technologies, demand response, energy efficiency, rate design, load forecasting, distributed energy resources, integration of retail and wholesale markets, and integrated resource

planning. I have testified or appeared before several state, provincial and federal regulatory commissions and legislative bodies. I have been an invited speaker at major energy conferences in Africa, Asia, Australia, Europe, North America, and South America. Finally, I have authored, co-authored or co-edited more than 150 articles, books, editorials, papers and reports on various facets of energy economics. More details regarding my professional background and experience are set forth in my Statement of Qualifications, included as Exhibit AF-1 attached to my Direct Testimony.

Q. WHAT ARE YOUR RESPONSIBILITIES AS A PRINCIPAL OF THE BRATTLE GROUP?

A. I lead the firm's practice in helping clients understand and manage the changing needs of energy consumers.

Q. HAVE YOU PREVIOUSLY TESTIFIED IN REGULATORY PROCEEDINGS RELATED TO THE DEPLOYMENT OF ADVANCED METERING INFRASTRUCTURE ("AMI")?[1]

A. Yes. I testified in California on behalf of Pacific Gas & Electric Company and Southern California Edison, in Connecticut on behalf of Connecticut Light &

[1] For purposes of my testimony, AMI refers to advanced meters that enable two-way data communication, a secure and reliable communications network that supports two-way data communication, along with related and supporting systems, including a Meter Data Management System ("MDMS"), an Outage Management System ("OMS"), and a Distribution Management System ("DMS") – which, in the case of EMI, are planned to be integrated with its legacy IT systems via an Enterprise Service Bus ("ESB"). Similar deployments in other jurisdictions are sometimes referred to as an "Advanced Metering System" or "AMS." For simplicity, I use the term "AMI" throughout my testimony.

Power, in Illinois on behalf of Ameren and Commonwealth Edison, in Maryland on behalf of Baltimore Gas & Electric and Pepco Holdings, Inc., and in Washington, D.C., also on behalf of Pepco Holdings, Inc.

II. SUMMARY

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?

A. The purpose of my direct testimony is to support the reasonableness of the methodology and assumptions used by EMI to quantify certain non-operational benefits associated with the Company's planned deployment of AMI, as described in the Direct Testimony of EMI witness Mr. Jay A. Lewis as "Other Benefits." The primary focus of my testimony is on the expected impacts of new, more detailed information and enhanced tools (*e.g.*, the ability to estimate a bill) that will be made available to customers as a result of the AMI deployment. The new information and enhanced tools provide customers with actionable information that would lead them to change their energy consumption in a manner that reduces electricity system costs and can lower customer bills.

I also review and comment on some other elements of the proposed AMI deployment. These are EMI's proposed advanced meter opt-out policy and the benefits arising from reductions in what is called "unaccounted for energy" ("UFE"). Throughout, I provide a general review of the overall methodological framework of these quantified benefits for consistency with established industry practices.

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. EMI's AMI deployment will provide significant benefits which could not be achieved without upgrading its existing metering infrastructure. Customers will have access to new information about their energy use that previously could not be provided due to technological constraints of the legacy metering system. In response to this information – delivered through a web portal, text alerts, and email notifications – customers are expected to change their energy consumption and manage their usage in a way that will save on fuel and capacity costs, and ultimately reduce bills for all customers.

EMI's AMI deployment will also allow EMI to reduce the current level of UFE. Within the electricity industry, the term UFE is used to refer to technical losses in the electricity system from sources like line and transformation losses, as well as non-technical losses resulting from electricity that is consumed by customers but not metered nor billed by the utility, typically due to metering malfunction or theft. The improved metering accuracy provided by AMI will help EMI mitigate non-technical UFE and reduce situations where customers are receiving electricity, but not paying for their full energy use. Addressing non-technical UFE should also lead to less overall electricity consumption, which will result in a net reduction in total electricity costs for all customers.

EMI's methodology for estimating the expected impacts of these features of the AMI deployment is consistent with that of utilities in other jurisdictions. The assumptions used in the Company's analysis align well with the recent

experience of these other utilities, much of which has been validated through empirical assessment of AMI pilot projects and full-scale AMI rollouts.

EMI's proposed opt-out policy will provide residential customers with the option to keep their existing meter (subject to certain safety and accuracy tests) or, if an advanced meter has already been installed, switch from an advanced meter to a non-advanced meter, as long as those customers are willing to cover their share of the associated cost of maintaining a legacy metering system, including manual meter reads each month. EMI's proposal is consistent with that of many other U.S. utilities. The proposed policy provides a pragmatic degree of choice to its customers, even though only a small number are likely to decide to opt out from having an advanced meter installed at their home.

Overall, the aspects of the AMI deployment that I have reviewed are reasonable, consistent with current industry practices, and demonstrate that EMI's AMI deployment will provide significant benefits to its customers.

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. The remainder of my testimony is organized as follows. Section III provides an overview of AMI experience in the U.S. Section IV is an assessment of the expected benefits of the new information and enhanced tools that will be provided to customers as a result of EMI's AMI deployment. Section V discusses other assumptions in the AMI deployment. Section VI summarizes the conclusions of my review of certain aspects of the AMI deployment.

III. AMI EXPERIENCE IN THE UNITED STATES

Q. HOW COMMON IS AMI TECHNOLOGY IN THE U.S.?

A. According to the most recent publicly available information, nearly 50 million U.S. households have advanced meters, accounting for more than 45 percent of all meters.[2] Nearly 200,000 advanced meters have been deployed in Mississippi.[3] There are also many examples of large utility AMI deployments in EMI's neighboring states in the Southern U.S. For instance, AMI has been deployed to over 7 million customers across Texas. Southern Company has deployed advanced meters to more than 4 million customers in Georgia, Alabama, and Florida. Florida Power & Light has separately installed nearly 5 million advanced meters in Florida. Oklahoma Gas & Electric has deployed over 850 thousand advanced meters in Oklahoma and Arkansas.

There has been continued growth in adoption of advanced meters over the past decade. I expect this growth trend to continue as utilities replace legacy metering systems and modernize their power grids. If the meter adoption rate continues to follow the historical trend, the vast majority of all electricity customers in the U.S. would have advanced meters by the time EMI has finished its deployment.[4]

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[2] EIA, Form EIA-826, "Advanced Metering" as of June 2016, *available at* https://www.eia.gov/electricity/data/eia826/#ammeter.

[3] *See* EIA Form-826 (June 2016).

[4] According to a 2015 Federal Energy Regulatory Commission ("FERC") report, there were around 13 million advanced meters in the U.S. in late-2009 and 50 million advanced meters by mid-2014. This implies average annual installations of around 8 million advanced meters per year. *See* FERC, 2015 Assessment of Demand Response and Advanced Metering, Staff Report, December 2015, p. 3, *available at* http://www.ferc.gov/legal/staff-reports/2015/demand-response.pdf.

Q. WHY HAVE ADVANCED METERS BECOME SO COMMON AMONG U.S. UTILITIES AND ALSO AMONG UTILITIES LOCATED OVERSEAS?

A. Utilities and regulators across the industry have recognized that new digital infrastructure is needed to modernize the grid so that utilities can keep up with advancements in energy technologies on both the supply and demand-side. AMI unlocks many benefits, both operational and customer-facing, which can reduce costs and improve reliability and quality of service for all customers. In its most recent annual report on advanced metering, the FERC Staff states that, "…deployment of advanced meters continues to progress throughout the nation's electric system, providing support for two-way communications networks that utilities can use to improve electric system operations, enable new technological platforms and devices, and facilitate consumer engagement."[5]

Q. HOW WILL THE DEPLOYMENT OF ADVANCED METERS IMPROVE THE CUSTOMER EXPERIENCE?

A. First, an upgraded metering system will enable the growing trend toward – and need for – greater customer engagement. For instance, rooftop solar PV installations are growing quickly in many regions of the U.S. Participation in demand response programs has also increased significantly in the past decade,[6] and many consumers are purchasing smart appliances, such as internet-connected

[5] *See id.*, p. 5.

[6] *See id.*, p. 17.

digital thermostats.[7] In short, utility customers are becoming more engaged consumers of energy, and AMI has become necessary to support this level of engagement.

Second, as I discuss throughout my testimony, the deployment of AMI will provide customers with access to new information that could not be provided through the existing metering system. Customers will be able to develop a better understanding of their energy consumption and when it occurs. In addition, they will receive various tips and alerts that will improve their overall experience as an energy consumer, and if followed, can result in lower individual customer bills.

Third, as quantified in Mr. Lewis' testimony, there are expected to be bill savings for all customers resulting from an overall reduction in consumption as a result of the new information about customers' energy usage available through AMI. Further, all customers will benefit from the operational cost savings provided by AMI.

[7] For instance, a survey of 1,600 customers in North America found that "50% of people [are] saying they plan to buy at least one smart home product in the next year (U.S. intent is slightly higher at 54%)." *See* Icontrol Networks, 2015 State of the Smart Home Report, June 2015, p. 3, *available at* https://www.icontrol.com/wp-content/uploads/2015/06/Smart_Home_Report_2015.pdf.

In addition, Berg Insight, a Swedish market research firm, reports that the number of smart thermostats in North America and Europe more than doubled in 2014. Their "Smart Homes and Home Automation" report also forecasts that this number will grow at a compound annual growth rate of 64.2 percent during the next five years. *See* David Murphy, "Smart Thermostat Sales Double in a Year," Mobile Marketing, January 12, 2015, *available at* http://mobilemarketingmagazine.com/smart-thermostat-sales-double-in-a-year/, last accessed August 31, 2016.

IV. THE IMPACTS OF NEW INFORMATION AND ENHANCED TOOLS IN EMI'S AMI DEPLOYMENT

Q. PLEASE DESCRIBE THE NEW INFORMATION AND ENHANCED TOOLS THAT WILL BE MADE AVAILABLE AS A RESULT OF EMI'S AMI DEPLOYMENT.

A. There are two aspects to what EMI is proposing to implement. The first is the incorporation of more detailed, time-differentiated usage data into the Company's customer web portal, which can be accessed through the internet by computer or mobile device.[8] In other words, through their computer or mobile device, customers will have access to enhanced usage and billing information, targeted energy saving tips, and other features like the ability to set targeted bill and usage alerts, which collectively comprise a robust resource of energy management information for electricity customers. EMI witness Mr. Robbin Jeter explains these features in more detail in his direct testimony.

The second aspect is the implementation of a peak event notification program for electricity customers, also described by Mr. Jeter. To reduce electricity demand during the small number of hours of the year that drive the system peak, notifications would be sent to customers encouraging a voluntary, temporary reduction in electricity use. My understanding is that these messages

[8] Data collected by the U.S. Census Bureau shows that internet access has increased over time. In 1997, 18.0 percent of households reported home internet use. By 2013, these estimates had increased to 74.4 percent. For the state of Mississippi, 62.3 percent were reported to have access to high-speed internet. I would expect this trend to continue, meaning internet access may be higher by the time the Company's AMI deployment is expected to start in 2019. *See* Thom File and Camille Ryan, "Computer and Internet Use in the United States: 2013," United States Census Bureau, November 2014, p. 4 and 10, *available at* http://www.census.gov/content/dam/Census/library/publications/2014/acs/acs-28.pdf.

could be sent in anticipation of a peak event by text and/or email (subject to an opt-out procedure and applicable legal requirements related to such communication channels). The program is expected to include post-event feedback, educating customers about the extent to which they reduced their peak electricity consumption, and which is only possible with the time-differentiated usage data produced by AMI. Following the AMI deployment, customers would be enrolled in the notification program, although as I understand it, customers can choose to not receive such notifications if they wish.

Q. HOW WILL THE NEW INFORMATION AND ENHANCED TOOLS BENEFIT CUSTOMERS?

A. The incorporation of the AMI data into the Company's web portal will give customers access to detailed and more up-to-date energy usage information to help them make better informed decisions about their usage. I expect some customers to reduce their overall electricity consumption in response to this enhanced information. Similarly, I expect some customers to reduce their peak demand when notified of peak events. The impacts of the information made available by AMI through the web portal and peak event notification program will translate into cost savings for EMI and ultimately for its customers. In the short run, the reduction in total electricity consumption will result in a reduction in fuel and variable operations and maintenance costs. In the longer-term, lower system peak demand should reduce fuel and capacity costs.

Q. WHAT HAS EMI ESTIMATED WILL BE THE IMPACTS OF THE NEW INFORMATION AND ENHANCED TOOLS ON ELECTRICITY USAGE?

A. EMI has estimated that the new information and enhanced tools made available through the web portal will lead to an overall reduction in residential and commercial electricity consumption of between 1.5 percent and 2.0 percent. EMI used the mid-point of that range (1.75 percent) to calculate consumption reduction benefits, as discussed in the Direct Testimony of Mr. Lewis. EMI has assumed that these energy savings will occur uniformly during peak and off-peak periods, resulting also in a proportional peak demand reduction of 1.5 to 2.0 percent. EMI used 1.75 percent as the midpoint of this range to calculate peak demand-related benefits as well. The peak event notifications are expected to lead to an additional reduction in residential peak demand of approximately 0.4 percent, with no associated energy savings. These assumptions are summarized in Table 1 and are discussed in more detail in the Direct Testimony of Mr. Lewis. Mr. Lewis quantifies the net present value of these impacts in his Direct Testimony.

Table 1
Impact of New Information and Enhanced Tools on Residential and Commercial Electricity Use

	Energy Savings	Peak Demand Savings
Web portal	1.75%	1.75%
Peak notifications	0.00%	0.38%
Total	1.75%	2.13%

Q. IN GENERAL, IS THERE EVIDENCE THAT CUSTOMERS RESPOND TO MORE DETAILED INFORMATION ABOUT THEIR ELECTRICITY USAGE?

A. Yes, there is empirical evidence in academic journal articles and industry reports indicating that customers respond to detailed information about their energy consumption. The studies have analyzed a variety of ways in which this energy information can be provided to customers. For instance, more than a dozen utility pilot projects implemented over the past decade found that customers reduce energy consumption when provided with new information that is displayed electronically and is easily accessible.[9] The means to display the information could be a screen reporting instantaneous energy use, an "orb" that glows different colors depending on energy consumption levels, or a web-based platform that the customer accesses from a computer or mobile device. Additionally, firms that offer a platform for certain types of energy efficiency programs, like OPower, have observed significant energy reductions when providing utility customers with bill inserts that compare their consumption to that of similarly-situated neighbors.[10] There have also been studies specifically on the impacts of providing AMI usage data through a web portal, similar to the

[9] Many of these studies are summarized in Ahmad Faruqui, Sanem Sergici, and Ahmed Sharif, "The Impact of Informational Feedback on Energy Consumption – A Survey of the Experimental Evidence," *Energy*, 2010, *available at* http://www.myaztech.ca/wp-content/uploads/faruqui_impactoffeedback_2010.pdf. *See also* Sarah Darby, "The Effectiveness of Feedback on Energy Consumption: A Review for Defra of the Literature on Metering, Billing, and Direct Displays," Environmental Change Institute at the University of Oxford, April 2006, *available at* http://www.eci.ox.ac.uk/research/energy/downloads/smart-metering-report.pdf.

[10] Studies have indicated that OPower's programs reduce residential electricity use by two percent on average. A full library of OPower's measurement and verification reports can be found here: https://opower.com/resource_type/verification-reports/.

capability that EMI proposes in its AMI deployment, which I will summarize later in my testimony.

Importantly, these studies have found that customers respond to new energy consumption information even in the absence of changes in price. Simply being better informed about their energy use in conjunction with new tools like targeted text alerts and conservation tips is enough to induce energy savings among some customers. Changes in the pricing structure, or the adoption of new home automation technologies, would further enhance response.

Q. IS EMI'S ASSUMED ELECTRICITY IMPACT FROM THE AMI USAGE DATA MADE AVAILABLE THROUGH THE WEB PORTAL AND RELATED ENERGY MANAGEMENT INFORMATION REALISTIC?

A. Yes. An estimate of 1.5 percent to 2.0 percent savings in energy consumption is reasonable and consistent with evidence from other jurisdictions. As I noted previously, Mr. Lewis has used an estimate of 1.75 percent, which is within this range. I am aware of similar estimates that have been developed by other utilities.

For instance, Potomac Electric Power Company ("Pepco") recently detected energy savings of 1.73 percent from a similar full-scale web-based offering.[11] The utility's offering is centered primarily around more detailed and time-specific information about each customer's electricity consumption, which is provided through both a web portal and the customer's bill. Pepco has offered

[11] See *Direct Testimony of Ahmad Faruqui on behalf of Potomac Electric Power Company*, Maryland Public Service Commission – Case No. 9418, April 19, 2016, p. 10.

this AMI information in Maryland since Spring 2013.[12] Pepco filed an empirical assessment of the impacts of its web-based AMI information as part of cost recovery proceedings before the Maryland Public Service Commission ("Maryland PSC"). I led the assessment of Pepco's AMI-enabled energy savings and have submitted testimony to the Maryland PSC in support of that analysis.[13]

Baltimore Gas & Electric ("BGE") has offered new AMI-enabled usage information to its customers since Fall 2012. BGE's offering includes interactive online tools, usage alerts, weekly usage emails, and home energy reports. BGE has reported energy savings of between 1.38 and 1.5 percent resulting from the provision of this information.[14]

Many other utilities that have deployed AMI included assumptions about the impacts of web-based AMI information in their AMI business cases. In some cases, such as those of BC Hydro and Southern California Edison, the assumed impacts reached 2.0 percent.[15] In the case of Entergy New Orleans, Inc.'s

[12] Additionally, Pepco Holdings began offering a web portal in its Delmarva Maryland jurisdiction in Fall 2014.

[13] *See* Faruqui testimony (2016).

[14] An evaluation by Navigant Consulting identified a 1.38 percent impact, and testimony by BGE witness William Pino refers to a 1.5 percent impact. See Navigant Consulting Inc., Smart Energy Manager Program – 2015 Evaluation Report, prepared for Baltimore Gas Electric, March 11, 2016, p. ii. See also Direct Testimony of William B. Pino on behalf of Baltimore Gas & Electric Company, before the Maryland Public Service Commission – Case No. 9406, November 6, 2015, p. 38.

[15] BC Hydro, *Smart Metering & Infrastructure Program Business Case*, p. 28, *available at* https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/projects/smart-metering/smi-program-business-case.pdf. Southern California Edison, *Rebuttal Testimony Supporting Edison SmartConnect Deployment Funding and Cost Recovery*, California Public Utilities Commission, Application No. A.07-07-026, February 19, 2008, p. 11.

("ENO") web-based AMI pilot, impacts were estimated to be 1.8 percent.[16] But what makes the Pepco and BGE cases particularly relevant is that they reflect **actual** impacts that were measured on an *ex post* basis. They are statistically significant estimates observed from customers across the utilities' entire respective service territories.

Q. DID PEPCO AND BGE HAVE PRE-EXISTING ENERGY EFFICIENCY OR DEMAND-SIDE MANAGEMENT PROGRAMS ("EE/DSM") WHEN THEY DEPLOYED AMI?

A. Yes. Both utilities offered robust EE/DSM portfolios prior to AMI deployment, and continue to do so.[17] The utilities have been working for years to achieve what I would consider to be substantial energy savings targets in Maryland.[18]

[16] ENO conducted a pilot program in 2011 and 2012 evaluating customer behavior in response to advanced metering and other technologies for low-income customers. While the average impact of the pilot was estimated to be 1.8 percent, the result was not considered to be statistically significant. This could be due to the relatively small number of participants in the pilot. *See* Navigant Consulting, Inc., *Entergy New Orleans SmartView Pilot, Final Evaluation Report*, August 30, 2013, Table ES-2, p. v. Additionally, Entergy Louisiana, LLC conducted a small pilot, but it did not include the types of information-only treatments that I am analyzing in my testimony.

[17] For more information on the utility EE/DSM offerings in Maryland, see the Pepco MD website, *available at* http://www.pepco.com/my-home/save-money-and-conserve-energy/efficiency-rebates-and-incentives-and-programs/md-customers/. *Also see* the BGE website, *available at* http://www.bgesmartenergy.com/.

[18] For more information, *see* the EmPOWER website, *available at* http://energy.maryland.gov/pages/facts/empower.aspx.

Q. ARE THE ENERGY SAVINGS ESTIMATES ASSOCIATED WITH BGE'S AND PEPCO'S WEB PORTALS INCREMENTAL TO THE IMPACTS OF THE UTILITIES' EE/DSM PROGRAMS?

A. Yes. The energy savings that are associated with BGE's and Pepco's web portals are entirely incremental to the energy savings that are attributable to the utilities' EE/DSM programs. In the Pepco study, which I led, I structured the analysis such that it isolated the impact of the web-based AMI information and excluded any effect from existing EE/DSM programs.

I did not conduct the cited analysis for BGE, but I have reviewed the final report describing the methodology in that analysis.[19] It is my understanding that the BGE study similarly excluded the impacts of existing EE/DSM programs when quantifying the energy savings associated with web-based AMI information.

Q. IN ADDITION TO OVERALL ENERGY SAVINGS, EMI HAS ASSUMED THAT THE AMI INFORMATION ACCESSIBLE VIA THE COMPANY'S WEB PORTAL WILL LEAD TO PEAK ELECTRICITY DEMAND REDUCTIONS. IS THEIR ESTIMATE REALISTIC?

A. Yes, EMI's estimate of 1.5 to 2.0 percent peak demand savings for residential and commercial customers due to incorporation of AMI data into the web portal is reasonable. Specifically, EMI has assumed that peak demand savings attributable

[19] *See* Navigant Consulting Inc. (2016).

to the accessibility of AMI data via a web portal is proportional to energy savings on a percentage basis. This assumption is consistent with that of other utility business cases and reasonable relative to recent empirical evidence.[20]

Three independent studies of behavioral energy efficiency programs have looked specifically at the extent to which peak savings differ from energy savings. The studies were conducted by Lawrence Berkeley National Laboratory ("LBNL"),[21] DNV-GL (on behalf of the California Public Utilities Commission),[22] and The Cadmus Group (on behalf of PPL Electric).[23] The studies evaluated actual load data for customers who were provided information about how their energy use compares to similarly-situated neighbors. I would expect the programs evaluated in these three studies to elicit the same type of response when that information is accessed through a web portal; in both instances, customers are responding to general information about their energy use as opposed to information that would be specific to the time of day.

[20] Both the BGE and Pepco studies that I mentioned previously assumed proportional energy and peak savings.

[21] Annika Todd et al, "Insights from Smart Meters: The Potential for Peak-Hour Savings from Behavior-Based Programs," Lawrence Berkeley National Laboratory Paper LBNL-6598E, March 2014, *available at* http://escholarship.org/uc/item/2nv5q42n#page-1.

[22] DNV-GL, "Review and Validation of 2014 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Draft)," prepared for the California Public Utilities Commission, March 1, 2016, p. 30, *available at* http://www.energydataweb.com/cpucFiles/pdaDocs/1441/Res3_1_PGE_HER2014_FINALdraft_forPublicComments.pdf.

[23] Based on evaluation of data supporting James Stewart and Pete Cleff, "Are You Leaving Peak Demand Savings on the Table? Estimates of Peak-Coincident Demand Savings from PPL Electric's Residential Behavior-Based Program," AESP working paper, 2014, available at http://aespnational2014.conferencespot.org/polopoly_fs/1.429338.1389116220!/fileserver/file/67651/filename/Session_3A_Peter_Cleff.pdf.

All three of the studies found that peak savings were proportionally **greater** than energy savings. One likely reason is that customers tend to have more discretionary load during peak hours (e.g., air-conditioning or lighting in unoccupied rooms), and thus more opportunity for savings. The LBNL study elaborates on this point:

> These results show that this pilot program rollout resulted in savings that are higher during peak hours. It is particularly interesting because the savings disproportionately *increase* during the peak hours. Without hourly data, one assumption that was commonly used (based on anecdotal evidence) was that this was not the case; that either the savings are spread out evenly in proportion to the electricity usage, or that savings are actually harder to achieve during peak hours.[24]

Thus, all of the available empirical evidence that I am aware of supports the conclusion that EMI has been conservative in its assumption that peak impacts of incorporating the AMI data into its web portal will be proportional to (and not greater than) energy savings.

Q. IN ADDITION TO PROVIDING NEW INFORMATION THROUGH A WEB PORTAL, EMI WILL SEND CUSTOMERS NOTIFICATIONS OF PEAK EVENTS. IS EMI'S ASSUMED IMPACT FROM THE PEAK NOTIFICATIONS REALISTIC?

A. Yes. In fact, the estimate of a 0.4 percent peak demand reduction among residential and commercial customers is conservative relative to studies elsewhere. The peak demand impacts of such notifications have recently been

[24] Todd et al (2014), pp. 6-7.

tested through pilot programs. Some utilities have begun to consider offering these notifications as an alternative to conventional demand response programs which require installing control equipment on individual sources of load like an air conditioner or pool pump.

In some cases, these notifications are being deployed on a full-scale basis. Most recently, the California Independent System Operator ("CAISO") issued "flex alerts" to customers in California in response to higher than expected demand driven by high temperatures, concerns about natural gas shortages at the Aliso Canyon storage facility, and challenging grid conditions caused by nearby wildfires.[25]

Several studies have estimated the impacts of these pilot programs in the past few years. I have identified seven such studies. Much like EMI's proposed method of deployment, most of these programs appear to have been rolled out on a default basis, meaning all participants were automatically enrolled in the program.[26] Aggregate peak demand reductions identified in the studies ranged from 1.7 percent to 5.8 percent.[27] The impacts estimated in each study are summarized in Figure 1, with EMI's assumption shown for comparison purposes.

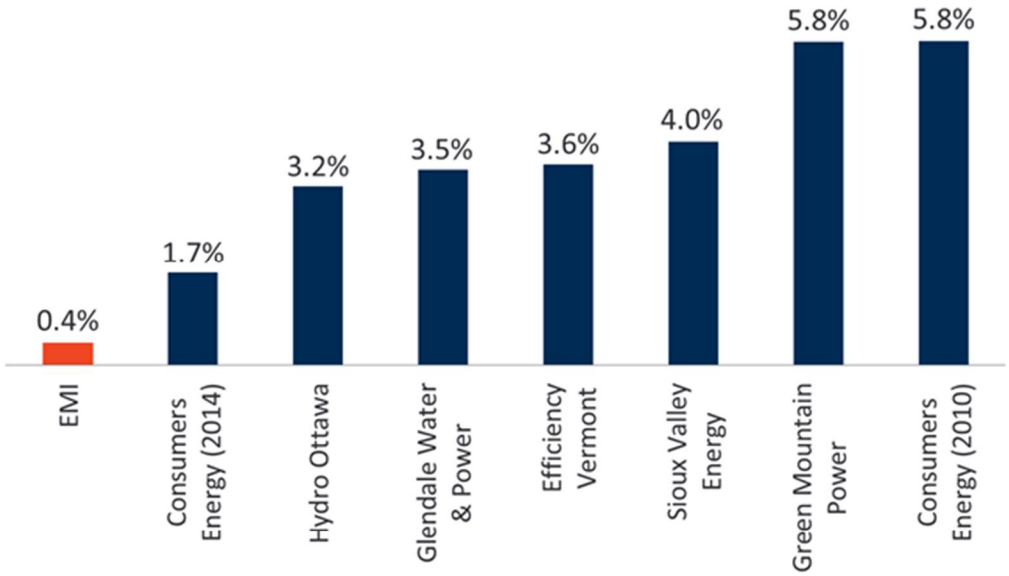
[25] Kassia Micek, "CAISO Calls on Consumers to Conserve Electricity," *Platts*, June 20, 2016, *available at* http://www.platts.com/latest-news/electric-power/houston/caiso-calls-on-consumers-to-conserve-electricity-21758647, last accessed September 2, 2016.

[26] Based on my review of the seven pilot studies shown in Figure 1, I believe only the Consumers Energy (2010) pilot included opt-in deployment. I believe all the other six pilot programs, including the Consumers Energy (2014) pilot, automatically enrolled customers to receive peak event notifications.

[27] While some of these seven pilots included a subset of customers receiving a financial incentive to reduce peak usage, all of the values provided in Figure 1 are based off information-only peak event notification programs.

Full citations to all seven studies are provided in Exhibit AF-2 attached to my Direct Testimony.[28]

Figure 1
Residential and Commercial Peak Demand Reductions from Behavioral Demand Response Programs



Notes:
[1] Value for EMI is assumption from AMI cost benefit analysis.
[2] Results for Green Mountain Power were not determined to be statistically significant.
[3] For pilots that reported a range of impacts, the midpoint of the range is shown.
[4] Impacts are average across all pilot participants and can be reasonably scaled to the class as a whole.

EMI's assumed residential and commercial peak impact of 0.4 percent is conservative relative to the range of findings of the pilots summarized in Figure 1. While I believe a higher assumed impact could be justified, it makes sense to be somewhat conservative with this assumption given that the industry has not been

[28] Note that the source document for the Consumers Energy (2014) result identifies the utility as CMS Energy, which is a holding company. The only utility subsidiary of CMS Energy is Consumers Energy, so I refer to the utility as Consumers Energy in Figure 1.

studying the impacts of these programs for as long as some other types of programs such as web portals.

V. OTHER ASPECTS OF EMI'S AMI DEPLOYMENT

Q. WHAT OTHER ASPECTS OF THE AMI DEPLOYMENT HAVE YOU REVIEWED?

A. I have reviewed EMI's assumed reductions in UFE and the Company's proposed advanced meter opt-out policy.

A. Benefits of UFE reduction

Q. WHAT IS "UFE"?

A. UFE reflects losses in the electricity system between the generator and customer meter. This includes line and transformation losses (or "technical losses") as well as electricity that is being consumed from the grid by customers but not metered nor billed by the utility (so-called "non-technical losses"). These non-technical losses could be due to meter malfunction, such as a meter that has slowed down over time or stopped working entirely. Or, non-technical losses could be caused by tampering and electricity theft. The cost of UFE, regardless of source, is borne by all customers as it effectively is treated as a system loss. This is further explained in EMI witness Lewis' Direct Testimony.

Q. WHAT HAS EMI ASSUMED REGARDING THE BENEFITS OF REDUCTION IN UFE?

A. As discussed by Mr. Lewis, EMI has assumed that roughly one percent of residential and commercial energy sales are unaccounted for currently due to non-technical UFE losses. EMI assumes it will be able to detect and address half of this one percent as a result of the AMI deployment. EMI further assumes that, once detected, half of this 0.5 percent, or 0.25 percent of all residential and commercial sales, will actually cease as a result of the detection, while the other half is converted to billable sales. Put another way, deploying AMI will allow EMI to improve fairness in revenue collection and reduce residential and commercial electricity consumption by 0.25 percent.

Mr. Lewis distinguishes two different types of benefits that this reduction in UFE will provide to EMI's customers. First, the 0.25 percent reduction in electricity consumption amounts to an avoided cost. That is electricity that EMI no longer needs to generate (or procure), so it translates into a cost reduction associated with the need for less fuel, which ultimately lowers the fuel adjustment for all customers. Next, the 0.5 percent UFE detection represents an overall improvement in fairness in revenue collection. As described above, the cost of that electricity was being borne by customers other than those who were consuming it. While there is not a net reduction in total system-level costs associated with correcting that until rates are next reset, it represents an improvement in fairness and equity and a reduction in bills for those customers

who were previously unintentionally covering the cost of the undetected electricity consumption.

Q. ARE THESE UFE-RELATED BENEFITS CONSISTENT WITH ASSUMPTIONS YOU HAVE OBSERVED IN OTHER APPROVED UTILITY AMI DEPLOYMENT APPLICATIONS?

A. Yes. Reduced UFE is a common benefit cited within approved AMI deployment applications. In fact, in an informal survey of approved utility AMI deployment applications and AMI cost recovery proceedings over the past few years, I identified eight that quantified the benefit related to reduced UFE. Those utilities are Ameren Illinois, Baltimore Gas & Electric, BC Hydro, Commonwealth Edison ("ComEd"), Consolidated Edison, Duke Energy Ohio, a joint filing by the Hawaiian utilities, and Public Service Company of Oklahoma. A complete list of citations to each utility AMI cost benefit-analysis is provided in Exhibit AF-2.

Regarding the magnitude of the UFE reduction, I have found that EMI's assumed reduction is consistent with that of other utility AMI cost-benefit analyses. For instance, ComEd estimated 0.91 percent of sales to be non-technical UFE. Like EMI, ComEd assumed that half of this UFE would be detected through the use of AMI. Of the detected UFE, ComEd assumed that 50

to 80 percent would cease, resulting in a net reduction in electricity use of 0.23 to 0.36 percent.[29] This is similar to EMI's assumption of 0.25 percent.

I believe it is reasonable to expect that some portion of UFE will simply go away once it is detected. Customers may become more energy efficient or curtail illicit use of electricity when faced with the full cost of the electricity that they were previously consuming. There is a vast literature in energy economics which shows conclusively that customers consume less electricity when the price increases (or in this case their overall costs).[30]

Finally, I have noted that avoided peak demand associated with the reduced UFE could also be included as a benefit in EMI's cost benefit analysis (similar to the avoided peak demand benefits from the web portal). EMI has not included this potential benefit of reduced UFE, focusing only on the avoided energy costs, and therefore the Company's estimate is conservative in this sense.

[29] (0.91% non-technical UFE sales) X (50% detected via AMI) X (50% ceased consumption) = 0.23%, and 0.91% X 50% X 80% = 0.36%. See Black & Veatch, for Commonwealth Edison Company. *Advanced Metering Infrastructure (AMI) Evaluation- Final Report*, July 2011, p. 117.

[30] See, for instance, Mark Bernstein and James Griffin, "Regional Differences in the Price-Elasticity of Demand for Energy," RAND Corporation Technical Report, 2005, *available at* http://www.rand.org/content/dam/rand/pubs/technical_reports/2005/RAND_TR292.pdf.

B. EMI's Opt-out Proposal

Q. EMI HAS PROPOSED TO ALLOW RESIDENTIAL CUSTOMERS TO VOLUNTARILY "OPT OUT" OF HAVING AN ADVANCED METER. WHAT DOES THIS MEAN?

A. As Mr. Davis describes in his testimony, EMI's proposed opt-out policy means that residential customers can choose to avoid receiving an advanced meter before their existing meter is replaced (subject to certain safety and accuracy tests), or can have their advanced meter (if already installed) replaced with a non-advanced electric meter. Those customers who opt out of the advanced meter would pay, in addition to standard residential rates and applicable riders, a fee that consists of an initial payment and a recurring monthly payment. The monthly fee would be designed to cover the costs of maintaining a redundant metering system as well as manually having their meter read each month. While not all utilities offer an opt-out option to their customers, allowing a customer to opt out is a common way to address the needs of the very small, but vocal minority of customers who have asserted privacy- or health-related concerns about advanced meters.

Q. DO YOU FEEL IT IS APPROPRIATE FOR EMI TO OFFER RESIDENTIAL CUSTOMERS THE OPTION TO OPT OUT OF AN ADVANCED METER?

A. Yes. That said, the credible evidence that I have seen suggests that advanced meters do not pose a health risk to customers, do not improperly infringe on customer privacy, or otherwise represent a safety risk. For instance, The California Council on Science and Technology found that there are no adverse

health effects associated with advanced meters.[31] Advanced meters do not come anywhere near the Federal Communication Commission's ("FCC") established limits for radiofrequency ("RF") exposure.[32] And to the extent that some customers have privacy, data security, or other concerns in spite of EMI's data protection policies (as described by EMI witness Mr. Rodney W. Griffith and Mr. Jeter in their testimony), those customers would have the option to opt out of an advanced meter.

To address the views of customers who feel strongly about these issues, I do believe it is pragmatic for EMI to give them the option to avoid having an advanced meter record and transmit their energy usage as long as those customers agree to pay for the additional associated costs that EMI would incur.[33]

Q. DO YOU AGREE WITH EMI'S PROPOSED METHODOLOGY FOR ESTABLISHING UPFRONT AND ON-GOING OPT-OUT FEES, AS DESCRIBED BY MR. DAVIS?

A. My understanding is that EMI is proposing to charge the full cost of opting out only to those customers who opt out of AMI, including administrative paperwork,

[31] California Council on Science and Technology, "Health Impacts of Radio Frequency Exposure from Smart Meters," CCST whitepaper, April 2011, *available at* https://ccst.us/publications/2011/2011smart-final.pdf.

[32] Electric Power Research Institute, "An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter," Report 1021126. December 2010, *available at* http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001021126.

[33] My understanding is that customers would be required to provide adequate notice and acknowledge via signed form that they have opted out of the advanced meter and accept the associated upfront and on-going fees.

the inspection of existing meters, the removal/installation of the relevant meter, customer service, manual meter reads, and billing each month. The cost will be spread equally across all customers who opt out, in the form of an up-front charge and a recurring monthly charge.

Conceptually, this approach makes sense. Otherwise, the customers who opt out would be unfairly subsidized by customers who accept a new advanced meter. Since customers that opt out would still receive benefits through reduced rates (due to reduced operational costs and fuel costs, for example), it is reasonable that opt-out customers should be required to pay other applicable residential rates and riders, including any MPSC-approved recovery of the AMI deployment.

Q. WHEN PRESENTED WITH THE OPTION, WHAT PERCENTAGE OF CUSTOMERS HAVE TYPICALLY OPTED OUT OF AN ADVANCED METER OFFERING IN OTHER JURISDICTIONS?

A. Even in PG&E's Northern California service territory, where the most vocal opposition to advanced meters surfaced a few years ago, the percentage of customers who opted-out is only around one percent.[34] That is one of the highest opt-out rates that I am aware of. In other utility cases, including other utilities in California, the opt-out rate is only a fraction of one percent. Only a very small

[34] That is 52,205 customers who were enrolled in PG&E's SmartMeter Opt-Out Program as of October 2015 out of a total of 5,518,718 customers. See *California Smart Grid – Annual Report to the Governor and the Legislature, in Compliance with Public Utilities Code 913.2*, California Public Utilities Commission (January 1, 2016), p. 17 and EIA Form EIA-826 (December 2015), "Sales and Revenue."

portion of a utility's customers are expected to opt out of an advanced meter offering.

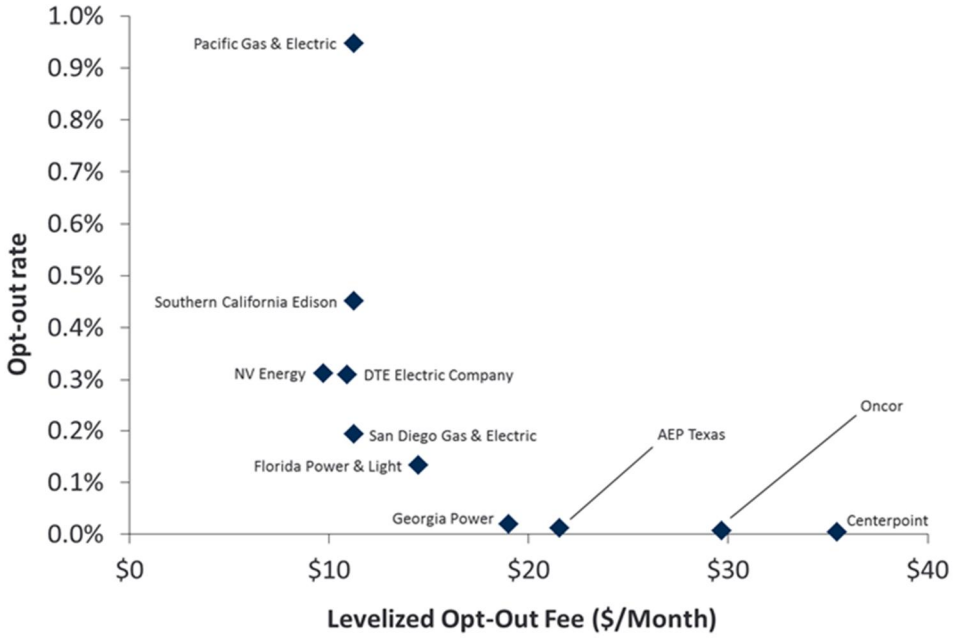
Figure 2 summarizes AMI opt-out rates from a number of North American utilities.[35] Because the opt-out rate is likely influenced in part by the magnitude of the opt-out fees,[36] I have included the on-going monthly fee on the horizontal axis.[37] Support for the information shown in this figure is provided in Exhibit AF-3 attached to my Direct Testimony.

[35] I reviewed the analysis in Mr. Lewis's testimony and Exhibit JAL-6 and have reproduced those opt-out rates here.

[36] Other factors that could influence the opt-out rate are the amount of time that has passed since the meter opt-out policy was put in place, differences in perceived risk from advanced meters across utility service territories, and the extent to which advanced meters enable various customer-side benefits that customers would not want to forgo by opting out.

[37] The fee is commonly composed of an initial, one-time payment plus an ongoing monthly payment. In these instances, I have levelized the one-time-payment over an assumed period of 60-months and added it to the monthly fee in order to create an average all-in monthly fee that is comparable across the utilities.

Figure 2: Opt-out Fees and Rates from Selected Utilities with Publicly Available Opt-out Data



Notes:
[1] Opt-out rates are calculated as the number of customers who opt out divided by total customers as of December 2015. Number of customers who opt out are based on the latest publicly available data, which spans a period from 2012 to 2016 depending on the utility.
[2] The initial opt-out fee has been levelized over an assumed 5-year period.

I have reviewed the illustrative opt-out fee example in Mr. Davis's testimony. Based on that review, I believe the assumed rate of 0.25 percent is reasonable relative to the utilities shown in Figure 2.

VI. CONCLUSIONS

Q. WHAT DO YOU CONCLUDE ABOUT THE REASONABLENESS OF EMI'S AMI PROPOSAL?

A. Advanced metering is a necessary platform to keep up with customer expectations in the digital age and to facilitate the integration of new energy technologies on both sides of the customer's meter. EMI's methodological framework for

assessing the costs and benefits of AMI is consistent with industry practices and includes reasonable assumptions that embody the latest available research on the topic. If anything, EMI has been conservative in its assessment of the many benefits of deploying AMI. In some cases, there are additional potential benefits of the AMI proposal which EMI has not quantified (e.g., peak demand reductions due to reduced UFE). There are also additional new AMI-enabled programs which EMI could offer in the future (e.g., dynamic pricing options). For these reasons, I believe the future realized benefits of EMI's proposed AMI deployment could be even higher than those quantified by Mr. Lewis.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes, at this time.