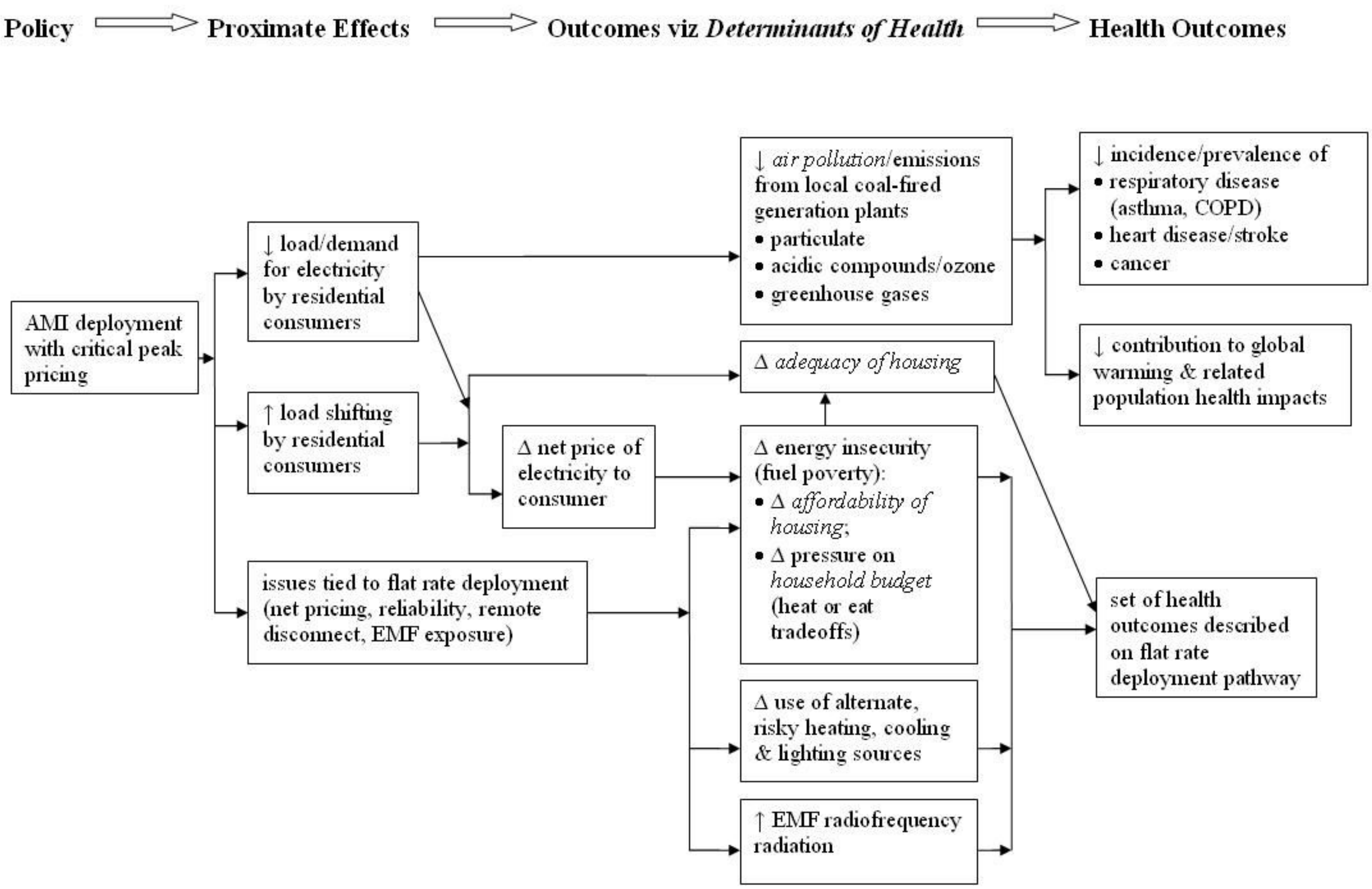
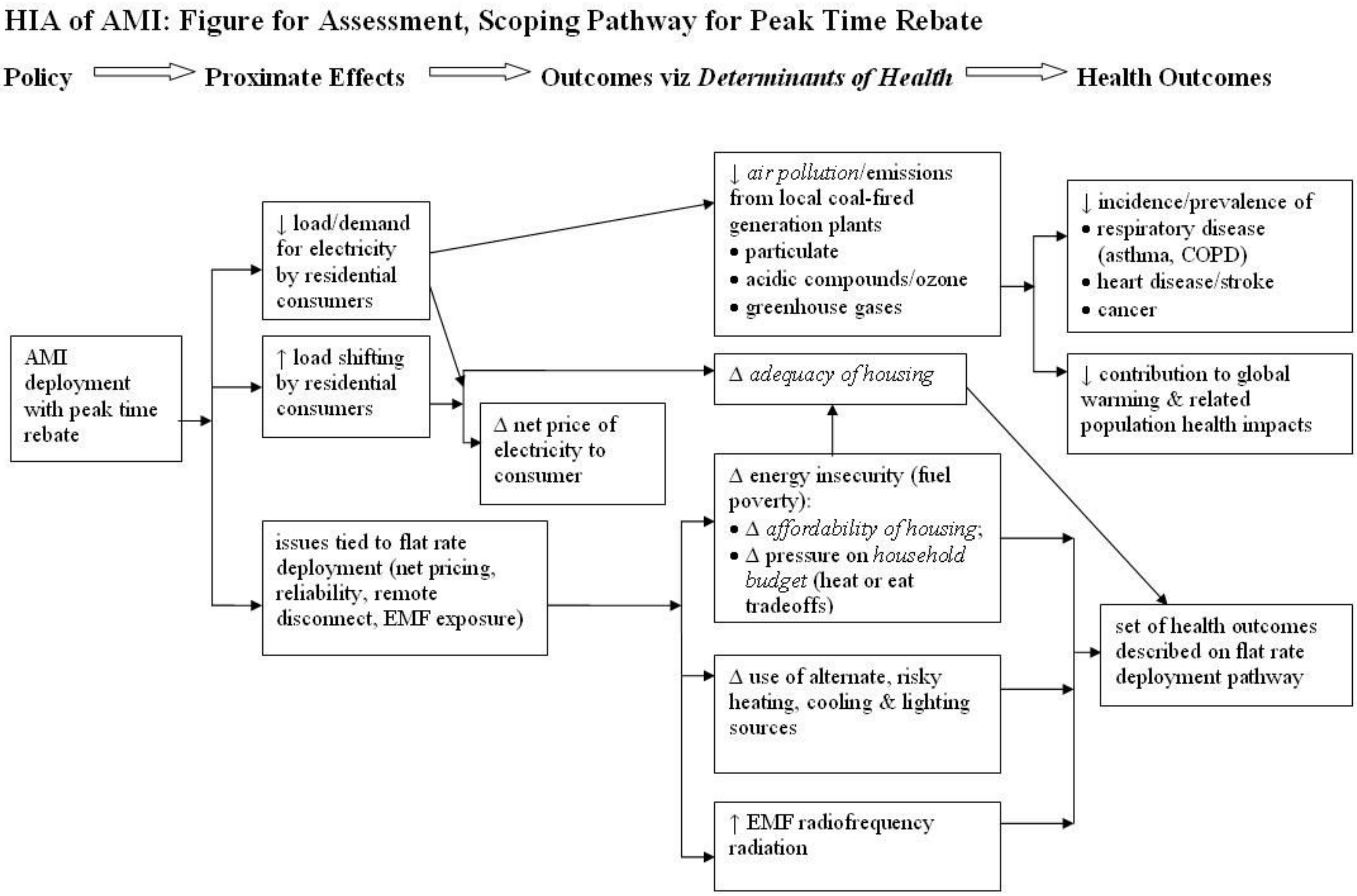
AARP-AG Exhibit 2.3
Part 3

PATHWAY: CRITICAL PEAK PRICING

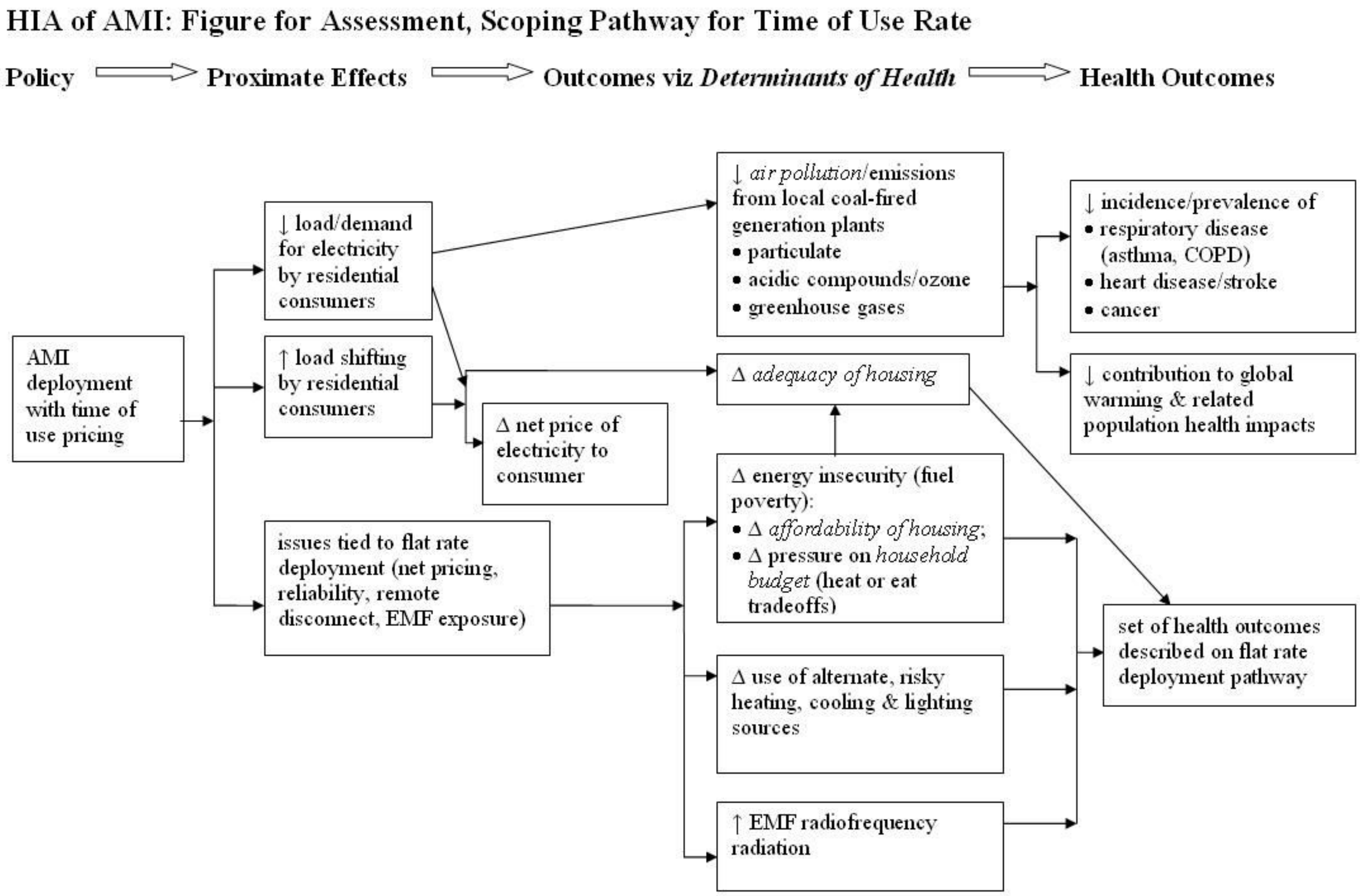
HIA of AMI: Figure for Assessment, Scoping Pathway for Critical Peak Pricing



PATHWAY: PEAK TIME REBATE



PATHWAY: TIME OF USE PRICING



APPENDIX 3: EXPERIENCE IN AMI DEPLOYMENT IN OTHER STATES

The HIA evaluated pilot results from around the country where various forms of dynamic pricing and in-home technology were used. Among these, two examples stood out in terms of length of study and comprehensiveness of evaluation: California and Baltimore.

California: California conducted a statewide pilot program in 2003-2004 and gathered data for voluntary customer participation in a variety of dynamic rate options over a 15-month period. The pilot tested a Time-of Use (TOU) rate with a very high peak period price, a fixed price Critical Peak Price (CPP) component grafted onto the existing inverted block rate structure (the default rate structure for all residential customers in California) and a variable price CPP. The pilot documented a significant reduction in peak load usage with the CPP options, as well as modest overall usage reduction for TOU-only customers during the first year which almost completely disappeared by the second year. With regard to low-income customers, the evaluation determined that the elasticity of demand for these customers was essentially zero because these customers exhibited very little response to higher electricity prices. These limited findings, if replicated elsewhere, could be troubling because where there is inelasticity of demand for any subset of customers, the costs of the new metering system may not be offset by any customer benefits from lower supply charges.[48]

Baltimore Gas and Electric: The BG&E pilot conducted in 2008 (and continued in 2009 and 2010 with similar results) enrolled volunteers into a test of AMI and dynamic pricing. This pilot also tested CPP and PTR rates, as well as in-home displays to alert customers to high price periods. This pilot documented that customers exposed to dynamic peak pricing, such as critical peak pricing and peak time rebates, as well as an in-home display to alert the customer to the onset of more expensive power hours did reduce critical peak usage on average in response to these educational programs and price signals. However, the average usage for the customers participating in the dynamic pricing programs did not decrease. Instead,

[48] Charles River Associates, "Impact Evaluation of the California Statewide Pricing Pilot." 2005.

customers typically shifted, rather than reduced, their overall usage, the same result found from the California statewide pricing pilot. Customers responded just as favorably in terms of peak load reduction to PTR compared to CPP. As a result, BG&E's AMI proposal approved by the Maryland Public Service Commission relies on offering PTR to all its customers after the new metering system is deployed in 2013.[49]

Other recent pilot programs conducted by Connecticut Light and Power pilot in Connecticut[50] and Pepco in the District of Columbia[51], confirmed these overall results in that customers responded to both critical peak pricing and peak time rebate offers, and reduced usage during critical peak periods on hot summer days, but there was no statistically valid overall usage reduction by participants in the pilot programs. This result was also true whether or not the pilot customers were given (at no cost) in-home displays.

It is possible the new technologies under development will make overall usage reduction a reasonable objective, such as smart thermostats or other residential energy management systems coupled with appliance automation, as will the use of storage technologies such as off peak cold storage to address air-conditioning usage. Furthermore, other customer feedback studies have documented overall usage reduction, some relying on dynamic pricing, but most of these studies rely on direct load control technologies or educational initiatives that are not necessarily dependent on the installation of AMI. Nonetheless, it is likely that additional enhancements beyond the metering system itself will be needed to reduce overall electricity consumption. Additional devices (such as in-home displays) may increase the costs to consumers and may threaten the ability of lower income customers who cannot afford to purchase, install, and maintain such devices to actually experience bill savings to offset the AMI costs.

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[49] Faruqui Ahmad and Sanem Sergici (2009): BGE's Smart Energy Pricing Pilot Summer 2008 Impact Evaluation, The Brattle Group Inc., April 2009.

[50] Connecticut Light & Power. Connecticut Light and Power AMI Pilot Project: Plan-it Wise Energy Program. 2009. Available at: http://www.cl-p.com/downloads/Plan-it%20Wise%20Pilot%20Results.pdf?id=4294986558&dl=t

[51] PowerCentsDC. PowerCentsDC Program Final Report. 2010. Available at: http://www.powercentsdc.org/ESC%2010-09-08%20PCDC%20Final%20Report%20-%20FINAL.pdf

AMI DEPLOYMENT AND REMOTE DISCONNECTION

AMI's two-way functionality enables remote disconnection of service for nonpayment. A handful of states have developed regulations that consider the health and safety implications of remote disconnection specifically.

Maine: In a proceeding held before the Maine Public Utilities Commission concerning Central Maine Power Company's (CMP) compliance with consumer protections obligations in an alternative rate plan, CMP submitted evidence concerning the actual actions taken by the Company to effectuate its disconnections of service. Of the over 54,000 notices that were "worked" in 2008, almost 30,000 (almost 60%) were left connected.[52] The reasons for those left connected include collection of funds, check, customer showed receipt, customer made arrangements, declaration of medical emergency, leaving a "green card", etc. Thousands of customers avoided disconnections by having contact with the field worker at the time of disconnection. The Company exercised its discretion to not disconnect service based on what occurred at the time of physical disconnection of service. This discretion could not be exercised with the use of remote disconnection.

California: In a tragic example of the risks of using alternative sources of lighting after loss of electricity, four children died in a fire sparked by a candle in a Fairfield, California apartment without electricity after PG&E remotely disconnected service in April 2010. A candle set atop a TV, with combustible materials nearby, started the blaze, according to Fairfield assistant fire marshal Jerry Clark. Two other candles had also been used. The Solano County District Attorney's Office continues to review the fire—ruled accidental— to determine whether any crime occurred and whether it would file any charges, said Al Garza, chief of that office's bureau of investigations. The mothers of the children, two sisters in their 20's, were not inside the home at the time of the fire but were outside in the nearby parking lot. One of the mother's stated that the home lacked electricity for about five days and that she and her sister had stepped outside to the laundry room next door to try to charge their cell phones.[53]

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[52] CMP Response to Oral Data Request 01-15, attachment 1 in Docket No. 2009-217 before the Maine PUC.

[53] Anthony, Laura. "Investigators: Fairfield fire started with candles." ABC News, April 29, 2010. Available at: http://abclocal.go.com/kgo/story?section=news/local/north_bay&id=7412580

Some states have prohibited the implementation of remote disconnection and refused to amend existing premise visit and contact requirements, including New York, Ohio, Maryland, and California, particularly because of the risks cited from alternative sources of heating and lighting.

New York: A 2007 decision of the New York Public Service Commission explicitly provided that current consumer protections relating to disconnection would be retained in the event that smart metering was implemented, thus preventing New York utilities from relying on any savings associated with remote disconnection of service.[54]

> The New York Commission stated,
>
> "Finally, we remind the companies that termination of service for nonpayment is subject to Home Energy Fair Practices Act (HEFPA) regardless of whether that disconnection is performed by physical (on site) or electronic (remote) service shut off. No utility may utilize AMI for remote disconnection of service for nonpayment unless it has taken all of the prerequisite steps required by HEFPA, including the requirement of 16 NYCRR §11.4(a)(7) that customers must be afforded the opportunity to make payment to utility personnel at the time of termination. This process requires a site visit, even where a remote device is utilized."

Ohio: Duke Energy filed for a series of waivers from Ohio's consumer protection rules to accommodate its smart grid pilot. The Company requested exemption from the rules requiring a premise visit from company personnel on the day of disconnection for nonpayment. The rules require a written notice be delivered to the named customer or an adult at the home, or posting of a notice providing information on assistance programs and other options to delay disconnection. Most importantly, the utility representatives are required to accept payment on the account in order to stop the disconnection. The latter requirement is also a part of Ohio statutory law.

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[54] See Order Requiring Filing of Supplemental Plan, Case Nos. 94-E-0952, 00-E-0165, and 02-M-0454 (December 17, 2007).

The Commission responded by denying this waiver request:

> In considering Duke's request, the Commission is aware of the purpose of Rule 4901:1-18-05(A)(5), O.A.C, which is to notify the occupants at the premise of the pending disconnection and allow the customer one last chance to prevent disconnection by making payment. Without personal notification, or the display of notice, it is possible that customers may be unaware of the pending disconnection, or may believe that the lack of service is the result of an outage. Moreover, the Commission agrees with OPAE's concern that customers who have not paid their utility bill may not have immediate access to text or electronic messaging, despite their selection of such means of notification at an earlier date. Therefore, while the Commission may be willing to discuss alternative notice processes in the future, at this time, the Commission finds that the processes set forth in this rule should remain in force. Accordingly, the Commission finds that Duke's request for a waiver of Rule 4901:1-18-05(A)(5), O.A.C, should be denied.[55]

Maryland: Both Baltimore Gas & Electric and Pepco and Delmarva filed applications for AMI deployment and included the potential savings from relying on remote disconnection for nonpayment in their business cases to support this investment. The Maryland Public Service Commission rejected this proposal and required the utilities to continue to conform to the current regulation that requires the utilities to conduct a premise visit and attempt to contact the customer, including mandatory acceptance of payment when offered by credit card, to avoid disconnection where possible.[56]

California: The California PUC opened a proceeding to consider the implications of a rising number of disconnections, the impact of remote disconnection of service, and the general increase in customer nonpayment as a result of economic conditions. In an Interim Decision issued in July 2010, the Commission instituted new protections

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[55] Public Utilities Commission of Ohio, In the Matter of the Application of Duke Energy Ohio, Inc. for a Waiver of Certain Sections of the Ohio Administrative Code for SmartGrid Pilot Programs, Case No. 10-249-EL-WVR, Entry, June 2, 2010.

[56] In approving BGE's AMI proposal, the Maryland Commission stated, "We note that we have not approved any exemption from our regulations concerning termination of service for non-payment, and that nothing in this Order should be construed as changing this Commission's policies or regulations regarding termination of service for non-payment." Order No. 83531, Case No. 9208, August 13, 2010, at 19.

for some customers in the implementation of remote disconnection of service.[57] The Commission specifically refused to halt remote disconnection, but ordered utilities to conduct premise visits by employees with the capability of accepting non cash payment to those on “medical baseline” and “life support” customers, customers specifically identified in California. Qualified customers get additional usage to be billed at the lowest rate under their applicable inverted rate structure. A typical utility application for this program requires the customer to provide identifying information and the “medical doctor or doctor of osteopathy” must certify a specific life support device, or that the patient needs specific heating and/or cooling due to certain conditions, “compromised immune system, life threatening illness or other condition for which additional heating or cooling is medically necessary to sustain the person’s life or prevent deterioration of the person’s medical condition.” The certificate can be for a specific period of years or permanent, in which renewal every two years is required. A specific list of “life support” equipment is listed, including breathing machines, motorized wheelchairs, pressure pads and pumps, respirators, etc.

[57] California PUC, Interim Decision Implementing Methods to Decrease the Number of Gas and Electric Utility Service Disconnections, Docket No. R. 10-02-005 (July 29, 2010)

APPENDIX 4: ESTIMATES OF SMART GRID IMPACT ON RELIABILITY

A recent report funded by the National Association of Regulatory Utility Commissioners (NARUC) for the Illinois Commerce Commission (ICC) examined impacts of smart grid investment, including AMI, on customer reliability of service, but it is important to note that this HIA is focusing on AMI and not smart grid per se.[58] Smart grid reliability investments should cause changes in the average duration of interruptions (CAIDI), changes in the average frequency of sustained interruptions (SAIDI) and changes in the average frequency of momentary interruptions (MAIFI). From the point of view of evaluating the benefits of these investments, NARUC urges regulators to focus on the question of whether the expected or observed changes in these reliability indicators are large enough to justify the costs of the investments required to achieve them. To answer these questions three pieces of information are required:

- The utility costs required to achieve given levels of reliability (i.e., investment, maintenance and operating costs);
- The changes in CAIDI, SAIFI and MAIFI that will result from a given Smart Grid investment or set of investments; and
- The average economic losses resulting from the units described above (i.e., CAIDI, SAIFI and MAIFI). For example, we need to develop estimates of how much a CAIDI minute costs customers, how much a SAIFI event costs and how much each momentary is worth.

The cost of unreliability is the product of the second and third points made above. In general, the reliability benefit is calculated by comparing the outage costs that occur in a baseline condition (i.e., existing SAIFI, CAIDI and MAIFI), with the outage cost that occurs (or is expected to occur) as a result of the investment. The difference in the cost of unreliability for the baseline condition and the cost that results from the investment is the reliability benefit; and the ratio of the reliability benefit to the investment cost (1) is the relevant cost-benefit ratio.

Utilities benefit because they are able to bill and collect for more kWh when outage duration is reduced or their frequency is lowered, thus increasing their revenues. Furthermore, the report to the ICC concludes that benefits to customers are often underestimated because utilities typically do not know how to assign an economic value for avoided economic losses due to unreliability. Finally, the report assumes that reduced expenses incurred by the utility to find and fix outages (associated with the access to real time information and the ability to ping the AMI meter to determine if it is on or off) will be captured and reflected in regulated utility operating cost reductions and passed through indirectly to customers.

APPENDIX 5: BLACK & VEATCH EVALUATION OF COMED'S AMI PILOT, COSTS AND BENEFITS

ComEd's operational pilot was evaluated by Black & Veatch Corporation in the summer of 2011 and this report contains preliminary information on its estimates of AMI costs and impacts.[59] Black and Veatch estimated the costs and benefits to ComEd and its customers over a 20-year period from 2011 to 2030 for two different scenarios: deployment of AMI throughout ComEd's system over a five-year period and a ten-year period.

According to the Black and Veatch report, during a five-year deployment period (at the end of 2012 through the middle of 2016) ComEd will invest and spend $1.042 billion or around $260 per ComEd meter (household).[60] Total operational and pass-through benefits to customers will be less than $400 million. According to this analysis, significant operational benefits will not begin to offset the AMI costs until 2017.[61]

Once the system is fully deployed, beginning in 2017, ComEd will incur annual expenditures for the AMI system of approximately $35 million and the Report estimates that savings of approximately $240 million annually will occur in the form of reduced operational expenses. A portion of these savings is composed of reduced operational expense relating to the elimination of manual meter reading and the use of remote functions that eliminate premise visits and field trips ($76 million), reduced bad debt and power purchase costs ($68 million), and higher revenues ($78 million). Ignoring these "pass through" benefits, Black and Veatch estimates the ratio of operational benefits to costs is $76 million to $35 million, and notes that "the difference of [approximately] $40 million may not represent enough cost savings to pay back the initial investment of over $1,100 million over a reasonable time period, so consideration of the past through benefits are material." Black and Veatch conclude that the AMI investment would pay for itself in ten years,[62] with customers seeing positive value (a decrease) in ComEd revenue requirements around year 8 of

59 Citation to Black and Veatch Report (Version 1.0), April 2011.

60 Black and Veatch Report at 37.

61 Black and Veatch Report at 37.

62 Black and Veatch Report at 40.

deployment.[63] The net present value of the AMI investment was estimated at $532 million.[64]

Deployment of the meters over a ten-year period produces essentially the same results, though the "stretching out" of costs and benefits tended to reduce the overall project value by around 15%,[65] making the payback period 11 years and the net present value of the investment $447 million.[66] Total deployment costs rose to $1.683 million and total operational benefits dropped to $1.563, with pass through benefits of $2.855 million.[67] Black and Veatch notes that some investments required for AMI deployment, such as investments in information technology, are unlikely to be stretched out over a ten year period.[68] Most importantly for an operational business case, Black and Veatch noted that their assumption that meter pricing for a ten-year deployment would not change was a "somewhat speculative assumption" since meter pricing might be higher or lower depending upon the nature of ComEd's contracts with meter suppliers and its chosen RF communication systems provider.[69]

Operational Benefits

Black and Veatch included the following categories of expense in their business case which showed a reduction in cost as a result of the deployment of AMI:

- Reduced costs of meter reading through reduced labor and transportation costs since manual meter reading would be almost eliminated.
- Reduced customer care costs through the elimination of estimated bills, which is among the top three customer complaint categories ComEd handles.[70]

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[63] B&V Report at 39.
[64] B&V Report at 40.
[65] B&V Report at 38.
[66] B&V Report at 41.
[67] B&V Report at 41.
[68] B&V Report at 40.
[69] B&V Report at 40.
[70] B&V Report at 71. Black and Veatch noted that complaints about high bills, by far the most common calling reason, broke down into three general categories: complaints due to high temperatures, complaints due to estimated bills, and complaints due to inaccurate final meter reads.

- Reduced outage management costs since ComEd could determine remotely whether the customer's power had been restored and avoid field trips for this purpose.

- Reduced unaccounted for energy (UFE) through the reduction of theft and tamper conditions, and reduced power purchase costs for empty buildings.[71] Black and Veatch also noted that ComEd has distribution line losses and unbilled energy usage rates that exceed the utility industry as a whole.[72] The evaluation estimates that theft and tamper conditions will be reduced with AMI, and so UFE will decline. Black and Veatch also included among their operational benefits increased revenues from the remote disconnection of electricity at premises where no account was associated (recorded as "Consumption on Inactive Meter" or CIM). Under current operations (prior to AMI), there are instances of metered consumption (at a premise) without an active customer account. These occurrences are usually the result of limited field work capacity to physically disconnect electricity at a premise after finalizing an account. [See fn. 2 and 3, page 1]

- Black and Veatch estimated a reduction in bad debt or uncollectible expense as a result of the use of remote disconnection of service for nonpayment, stating, "The evaluation includes estimates for the reduction in bad debt. By using new business practices in conjunction with the disconnect switch automation, ComEd estimates that it will be able to cut off customers more quickly as these customers accumulate a larger and larger uncollectible debt."[73]

Black and Veatch's evaluation of the operational benefits excludes the costs and benefits associated with the impacts of premature retirement (replacement) of existing meter assets and any sunk costs associated with the AMI pilot. Finally, Black and Veatch included several statements to qualify the cost and benefit estimates in the report:

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[71] B&V Report at 28.
[72] B&V Report at 64.
[73] B&V Report at 29.

- The estimated net customer impact and cash flows are offered as useful estimates, but are not offered as final and definitive work products for ComEd's regulatory filing requirements for cost recovery.
- Black & Veatch has no control over many variables that may influence the actual implementation and support costs, avoided costs, and other benefit categories of a proposed future deployment of AMI (e.g., actual labor costs, outcomes of vendor solicitations, price inflation, etc.) ComEd's actual implementation experience and results may vary from cost and avoided cost estimates provided in this report.

APPENDIX 6: LITERATURE REVIEW, HEALTH ASSESSMENT

This literature reviews the published evidence on potential and likely impacts of AMI, focusing on two subsets of literature as identified by the scoping pathways: fuel poverty and housing quality, and air quality and temperature (both indoor and outdoor). All four scoping pathways share the same set of health determinants and hypothesized range of health outcomes, irrespective of the type of rate plan for electrical service (flat, critical peak pricing, peak time rebate, or time of use) The search strategy began with a group of meta-reviews published since 2000 (Braubach et al., 2011; Thomson et al., 2009; Astroma et al., 2011; Liddell and Morris, 2010; Marmot Review Team, 2011; Snyder and Baker, 2010) , expanded by citation searching on Pub Med based on publications cited by the meta-reviews. NEADA's survey of LIHEAP recipients is another important source, not only to develop a health profile of Commonwealth Edison customers but also to document the ways in which low-income households respond to high home energy costs.

Fuel Poverty

The financial pressures of trying to pay high home energy bills, and related decisions not to use needed electricity in order to avoid high bills, leads to tradeoffs among household budget items that are often labeled "heat or eat." A national telephone sample survey across 13 states offers a window into the choices made by low-income households that receive federal energy assistance grants (LIHEAP) (NEADA, 2011): In response to high home energy bills, 72% of energy assistance recipients reduced expenses for household basics, 24% report going without food for at least one day, 37% report going without needed medical or dental services, and 34% go without the appropriate dose of a prescribed medication (NEADA, 2011). A variant of this phenomenon might be labeled "cool or eat" and refers to the influence of concern about the cost of electricity in summertime on the decision to use air-conditioning, even during a heat advisory. A survey of seniors in four cities (Dayton, OH; Philadelphia, PA; Phoenix, AZ; and Toronto, Ontario), about their responses to heat health warnings in the aftermath of hot weather events, finds that while about 90 percent of the respondents in US cities report having access to air-conditioning, and about the same percentage use their a/c during a heat event, about one-third report that the perceived cost of using air-conditioning influenced their decision about how and when to use a/c; this cost-consciousness was much higher in Toronto, where air-conditioning is less common and less commonly used (Sheridan, 2006). About 41 percent of respondents live along, a risk factor for social isolation and heat-related injury and premature death.

Food Insecurity:

- Regional patterns in hunger among low-income senior households are likely to reflect heating and cooling costs (Nord and Kantor, 2006). In the United States, seniors living in poverty in low-income households are more likely to report going without food in late winter, while those in Southern states are more likely to go hungry in late summer.
- During the winter months, low-income households (earning less than 150% of federal poverty) spend $11 less on food and $37 more on fuel for every 10 degree C drop in temperature during the winter months, compared with households earning at least 300% of federal poverty (Bhattacharya et al., 1992). Adults in these low-income households took in 7.9% fewer calories and children 10.9% fewer calories during wintertime, compared with members of higher-income households.
- Infants and young children in households experiencing energy insecurity are two to three times as likely to also be facing food insecurity and hunger (adjusted OR=2.37 for households with moderate energy insecurity and adjusted OR=3.06 in the case of severe energy insecurity) (Cook et al., 2008).[74]

Health and development:

- Infants and young children in families that are eligible for and not enrolled in energy assistance (LIHEAP) are more likely to need hospital admission on

[74] Household energy insecurity is measured in terms of answers to 4 questions:

- In the past 12 months, has a utility sent a letter threatening to shut off service for nonpayment?
- In the past 12 months, has the primary caregiver used a cooking stove to heat the home?
- In the past 12 months, were there any days that the home was not heated or cooled because bills could not be paid?
- In the past 12 months, has the utility shut off service or refused to deliver oil for not paying bills?

A respondent household is categorized as energy security if the answer to all four questions is no. If the first question is answered in the affirmative, the household is categorized as moderately energy insecure. If at least one other question in addition to the first one is answered in the affirmative, the household is categorized as severely energy insecure. Cook et al., 2008.

the day of a routine medical visit, compared with children in families that are enrolled in LIHEAP (Frank et al., 2006).

- Children in moderately or severely energy insecure households are more likely to be in poor health (adjusted OR=1.34 for moderate energy insecurity, adjusted OR=1.36 for severe energy insecurity), and children in households reporting moderate energy insecurity are more likely to have been hospitalized since birth (Cook et al., 2008).

Shutoff of Service:

Nationally, households that receive energy assistance grants are more likely to lose their service for nonpayment (NEADA, 2011):

- Almost half (45 percent) report home energy bills over $2,000 annually, with energy costs averaging 12 percent of household income even after energy assistance is received, compared with a national average of 7 percent of household income

- Nearly half (49 percent) report not paying their bill in full, with one-third (37 percent) receiving notice from their utility of a planned disconnection for nonpayment and 11 percent experiencing a disconnection in the past year.

Adequacy of Housing:

The physical environment of a home itself has myriad influences on health, some related to the fiscal strains associated with energy insecurity and of poverty itself, and others related more specifically to AMI, for example, exposure to non-ionizing radiation from the meter. NEADA's survey of energy assistance recipients documents a range of ways in which energy insecurity influences how householders use their homes (NEADA, 2011):

- In response to high home energy bills, 39 percent reported closing off part of their home, 23 percent reporting maintaining an indoor temperature that they considered to be unsafe or unhealthy, and 21 percent leaving their home for at least part of the day.

- About one-quarter (24 percent) report being unable to use their primary heating source because of a disconnection for nonpayment, being unable to pay for the delivery of fuel, or being unable to pay to fix a broken heating system, and 17 percent could not use their air-conditioning on account of disconnection of electrical service for nonpayment or being unable to pay to fix a broken system.

Overcrowding is one result of such responses. One evaluation of a British weatherization program finds that lowering home energy bills reduces overcrowding caused by the closing off of rooms that were too cold or costly to heat, in turn improving the mental health status of residents and reducing adolescent school truancy and criminal activity (Liddell and Morris, 2010). Houses that could be kept warmer more affordably improved social capital, or civic connections, as measured by reports of more time spent at home, the hosting of visitors, greater privacy, and strengthened relationships within the household (Thomson et al., 2009).

Access to heating promotes health. Evidence comes almost exclusively from studies of households in the United Kingdom.

- A survey of English working-aged adults finds that inadequate home heating has more of an influence on self-reported health than does indoor moisture (Evans et al., 2000).
- Evaluation of a Scottish weatherization program finds that the odds of indoor environmental problems decreases (OR=0.94) with the hourly increase in indoor heating duration (Walker et al., 2006).
- Seniors are more likely to die during the winter months (OR=1.016) if they live in a home without central heating (Aylin et al., 2001).
- An index of high neighborhood fuel poverty predicts the greater likelihood that seniors will be hospitalized in wintertime, compared with summertime (Rudge, 2005).

Access to cooling, and in particular central air-conditioning, is the single most significant factor predicting positive health outcomes during summer, in the United States and around the globe. Since the 1960s in U.S. cities, the number of heat-related deaths has declined, at first in southern cities (1980s) and then in northern cities (1990s), explained in part by greater access to air conditioning (Davis et al., 2003), also reflected in the decline in the risk of death from cardiovascular disease with increasing outdoor temperature (Barnett, 2007). Persons living in homes without central air –conditioning are 42 percent more likely to die, compared with those who do have central a/c; (Rogot et al., 1992). A smaller protective effect is seen for window units in smaller homes.

- During heat waves, the odds of death are lowered almost 80 percent when a home has a working air-conditioner (OR=0.23) and about 70 percent where there is access to a cool environment (OR=0.34) (Bouchama et al., 2007). Case-control review of 63 patients hospitalized as a result of a 1999 Chicago heat-wave finds that having a working air-conditioner lowers the odds of death by 80 percent (OR=0.2), more than any other factor considered; living on top floor of building increases risk (OR=4.0) (Naughton et al., 2002).

- Even in the absence of a heat wave, air-conditioning saves lives. A study of premature summer deaths in four Midwestern cities (Pittsburgh, Chicago, Detroit, and Minneapolis-St. Paul) identifies a 5 percent higher heat-related death rate for African Americans, compared with white residents, finding that over two-thirds of this disparity reflects the lack of access to central air-conditioning reported among the African-American households surveyed in the study (O'Neill et al., 2005). A study of hospitalizations during California summer months (May-September, 1999-2005) finds that central air-conditioning, whether measured as ownership or use, reduces the risk of hospitalization, irrespective of household income (Ostro et al., 2010).

In the absence of clean, electrically-fueled central heating, unvented (gas-fueled) heaters and portable electric heaters pose respiratory health threats, especially to children, related to moisture and to accumulation of nitrogen dioxide.

- Moisture or Mold. Homes that are inadequately heated or cooled are more likely to contain moisture, from the condensation of warm indoor air against surfaces made cool by outdoor temperatures (winter) or capturing summertime heat that fosters the growth of mold. Mildew and mold-derived irritants are more likely to be result. A meta-analysis of studies derived estimates of over twice the likelihood (OR=2.2) for the development of childhood asthma where household dampness is present (Pekkanen et al., 2007) and almost two and one half times the likelihood (OR=2.4) where mold is present (Jaakkola et al., 2005, as cited in Braubach et al., 2011).

- Nitrogen Dioxide. The use of ovens, stoves, or kerosene-fueled portable heaters in lieu of electrical appliances presents hazards related to indoor air quality. A retrospective study of asthma among young children in the U.S.

finds an 80 percent greater likelihood (OR=1.8) of physician-diagnosed asthma when children live in homes where a gas stove or oven is used for heat (Lanphear et al, 2001). A study of young African American children (ages 2-6 yrs) who live in low-income Baltimore households with an asthma diagnosis finds that higher NO2 concentrations measured in bedrooms correlate with the use of a space heater, an oven or stove for heat and that higher NO2 levels are associated with more days with asthma symptoms such as wheezing that interfere with speech (RR=1.15), more coughing (IRR = 1.10), and nighttime waking due to symptoms (IRR = 1.09), although not with greater use of health care services (Hansel et al., 2008).

An evaluation of a New Zealand program that replaced such substandard heating sources in low-income housing finds a boost in indoor temperatures, lowering of moisture and nitrogen dioxide levels, and a reduction in health problems related to asthma: children are half as likely (OR=0.40) to visit a doctor for asthma, to be reported to be in poor health (adjusted OR=0.48) , and have fewer nighttime asthma symptoms (Howden-Chapman et al., 2008). The warmth added through weatherization alone is linked to fewer school days lost for children (OR=0.49) and fewer work days off for adults (OR=0.62) (Howden-Chapman et al., 2007).

Non-Ionizing (EMF) Radiation Exposure

Though all consumers may be exposed to some level of radio-frequency radiation in connection with the wireless communication capacity of the AMI digital meters, depending on the physical configuration of meters and the duty cycles, the health impact of these exposures remains unclear.[75] AMI digital meters emit non-ionizing

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[75] In considering likely exposures for consumers in households with digital meters, a number of factors are relevant, including

- The frequency and power density of transmission: the digital meter deployed by Pacific Gas & Electric has two transmitters, one operating at 902 MHz (maximum permissible exposure of 601 microwatts/centimeter squared) that will enable automatic meter reading, and the second at a higher frequency, 2.4 GHz (maximum permissible exposure 1000 microwatts per centimeter squared, a higher limit as higher frequencies are less well absorbed compared with lower frequencies), comparable to a wireless telephone, for use with a home access network.
- The distance between the wireless transmitter and the person exposed; the extent of exposure drops off logarithmically, or rapidly with increasing distance. At a distance from the transmitter of approximately 10 feet, exposure level approaches zero. Distance would also reflect the specific configuration of a digital meter or meters, for example, whether household members would be exposed to radiation from a single meter or a row of meters in the case of a multifamily dwelling.
- The duty cycle, or length of time over which wireless transmission takes place; estimates are that digital meters may be transmitting about 50% of the time once automatic meter reading is fully enabled. In addition, digital meters may serve as relays for signals from other digital meters, increasing the total time during which transmissions are occurring.

(EMF) radiation as part of their wireless transmission of usage information and operational status between a household and Commonwealth Edison.[76] There is considerable public controversy over the potential and actual health effects of non-ionizing radio frequency radiation to which consumers are exposed by means of wireless transmission. FCC regulation of non-ionizing radiation from electronic devices concerns the thermal effects on bodies, measured either in terms of standard absorption rate (SAR) or maximum permissible exposure (MPE).

There are very few reports that focus on digital or "smart" meters and their emissions; much of the literature draws on studies of cell phones and microwave transmission towers, which are not the same amount or length of exposure.[77] Some but not all of these considerations are taken into account in a modeling exercise published by CCST in its report: in a comparison of power densities of digital meter transmitters compared with cell phones and other common wirelessly transmitting appliances, digital meters transmitting 50 percent of the time are estimated to result in an exposure of 200 microwatts/centimeter squared at a distance of 1 foot, compared with a range of 1,000 to 5,000 microwatts/centimeter squared for a cell phone exposure immediately adjacent (held to the ear), exposures of between 200 and 800 microwatts/centimeter squared for a microwave oven, and between 0.2 and 1 microwatt/centimeter squared for a home WiFi router.[78]

There is no scientific consensus about the range and extent of non-thermal health effects linked to non-ionizing radio frequency radiation given off by wireless transmitters and a need for more research in this area (NRC, 2008).

UNINTENTIONAL INJURIES AND PREMATURE DEATHS

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[76] Much of the discussion in this section is based on California Council for Science and Technology, Health Impacts of Radio Frequency Exposure From Smart Meters. Final Report, April 2011.

[77] Based on an expert review of studies of cell telephone usage, the World Health Organization's International Agency for Research on Cancer has labeled EMF radiation possibly carcinogenic to humans (Group 2B); a more comprehensive review is underway. According to the IARC, "This category is used for agents for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals. It may also be used when there is inadequate evidence of carcinogenicity in humans but there is sufficient evidence of carcinogenicity in experimental animals. In some instances, an agent for which there is inadequate evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals together with supporting evidence from mechanistic and other relevant data may be placed in this group. An agent may be classified in this category solely on the basis of strong evidence from mechanistic and other relevant data." (WHO/IARC, 2011).

[78] These estimates compare with the FCC limit for thermal injury of 601 microwatts/centimeter squared for devices transmitting at 902 MHz (the frequency of a digital meter's automatic meter reading radio) and the limit of 1,000 microwatts/centimeter squared for devices transmitting at 2.4 GHz (the frequency of a digital meter's radio for home access network communication). The safety standard regulated by FCC concerns the capacity of radiation to raise the temperature of body tissue (thermal effect), affecting behavior; non-thermal effects have been much more difficult to document.

Another health determinant that is the focus for this HIA is unintentional injury and death, related not only to fuel poverty and the adequacy of housing but also to how households respond to the loss of electrical service, particularly if someone in the home relies on an electrically-powered medical device, or to a consumer's decision not to use electrical service because of concerns about cost. Aside from the heightened risk of disconnection for nonpayment among low-income households, and the quicker pace of disconnections anticipated with AMI deployment, there are the fire and poisoning risks related to the use of gasoline generators, kerosene space heaters, gas stoves and ovens, and candles. Low-income households and seniors are acutely vulnerable: about one-quarter (26 percent) of households nationally that receive energy assistance grants include a member who uses a medical device that requires electricity, and one-third (33 percent) report have used their kitchen stove or oven for heat (McGwin, 1999; NEADA, 2011).

Carbon Monoxide:

Using gasoline-fueled generators to provide electricity or heat presents the threat of poisoning or death from carbon monoxide, an invisible, deadly gas. Exposure to carbon monoxide can cause effects ranging from headache and nausea to coma and death, with longterm neurological effects for those who survive exposure. Pregnant women, young children, elders, and people with cardiovascular or respiratory disease are more sensitive than average to the effects of CO. Recent studies estimate a 3% case fatality rate for CO exposure, based on data from hospitalizations (Sam-Lai et al., 2003 France; CDC, 2005) and up to 40% for neurological effects; an estimate 60% of reported CO poisonings are tied to home exposure (CDC, 2005; Clifton et al., 2001).

Fires:

A study of all single-family house fires over one year in North Carolina finds that heating equipment is the single most common cause of fires (39 percent of fatal fires and 28 percent of nonfatal) and that space heaters (for the part kerosene) cause 58 percent of fatal fires and 30 percent of non-fatal fires (Runyan et al., 1992). A number of state-level surveys conducted among similar lines, and one national retrospective analysis, find that African American elders are at higher-than-average risk of fire-related injuries and deaths, observations not directly related to poverty but hypothesized to reflect disparities in housing conditions (Bishai and Lee, 2010).

Exposure to Heat or Cold

Finally, health outcomes related to exposure to excessive heat or cold are an important concern of the HIA. The literature on the relationship between temperature exposure and health is voluminous, encompassing retrospective longitudinal observations of mortality differentials by season or weather event (deep freeze, heat wave) over years and decades, case studies of health services utilization during heat waves, and clinical studies detailing the physiological changes that accompany exposure. For the purposes of this HIA, the most relevant studies are those that document indoor temperature exposure, its relationship to energy use and to health and safety outcomes; a much smaller universe of literature makes the link to home energy and very few studies connect temperature exposure directly to energy.[79]

The responses of a population to ambient and changing temperatures reflect a number of factors: two key considerations include the capacity of built infrastructure (housing stock, landscape, roads) to concentrate or buffer weather conditions and the degree to which a population, and especially vulnerable subgroups, acclimatize or adjust in terms of physiological and behavioral responses to temperature, for example, through clothing, moderating outdoor activity, and having access to adequate indoor heating or cooling (Kovats and Hajat, 2008; Marmot et al., 2011). Mortality is one crude measure of this responsiveness; deaths are at a minimum in moderate temperature ranges and increase as temperatures climb or fall from a moderate range, with what constitutes a moderate range varying from region to region. A series of studies of temperature and mortality rates among U.S. cities finds that deaths increase by 2 to 4 percent per degree Fahrenheit as temperatures climb above a city's heat threshold and up to 6 percent per degree F with a drop in temperature below the area's cold threshold (Braga et al., 2001; Medina-Ramon and Schwartz, 2007; Anderson and Bell, 2009).

Exposure to cold:

A meta-analysis of studies linking winter outdoor temperatures to excess cardiovascular and respiratory disease deaths, for the most part based on data from

[79] For elders, this literature is reviewed in some detail in Snyder and Baker, Affordable Home Energy and Health: Making the Connections. Washington, DC: AARP Public Policy Institute, 2010.

the United Kingdom, Europe, and New Zealand, concludes that between 30% and 50% of premature deaths in winter reflect exposures to indoor cold (Rudge, 2011, based on Keatinge and Donaldson, 2000 for upper bound and Wilkinson et al., 2001 for lower bound). These otherwise avoidable deaths are associated with lower temperatures in bedrooms and living rooms (adults age 50+) (Eurowinter Group, 1997).

Exposure to heat:

Recent published summaries of the literature on heat exposure and heat waves highlight dozens of peer-reviewed studies documenting elevated rates of hospitalization and premature deaths.

- One such review identifies 29 studies where short-term rises in outdoor temperature are associated with greater risk or likelihood of premature death (Basu, 2009).
- Another review specifically concerning the experiences of seniors finds 6 peer-reviewed studies where a heat wave or summertime hike in temperature is associated with greater morbidity, and 24 peer-reviewed studies linking heat waves of higher ambient temperature with higher mortality rates (Astroma et al., 2011).

Young or advanced age, disabled status (especially a disability that limits mobility), African American ethnic identity, and social isolation or lack of social capital are each indicators of greater vulnerability to adverse impacts related to heat or cold exposure (Bouchama et al., 2007; Kilbourne, 2008; Schwartz. 2005, Medina-Ramon et al., 2007).

Chronic Illness and Temperature Exposure

- Heart Disease. Among adults and seniors, both heat and cold are associated with greater risk of hospitalization and premature death from cardiovascular and cerebrovascular (stroke-related) diseases (Alanitis et al., 2008; Medina-Ramon et al., 2006, Ostro et al., 2010, Semenza et al., 1999, Naughton et al., 2002).
- Respiratory disease. For elders, chronic obstructive pulmonary disorder is made worse by indoor cold: in wintertime, patients whose living rooms are warm (at least 21 degrees C, or approximately 70 degrees Fahrenheit) fewer

than nine hours per day have worse respiratory health than those who have at least nine hours of indoor warmth on a daily basis (Collins, 2000; Osman et al., 2008). Children are more than twice as likely to experience respiratory symptoms when they live in cold homes, compared with those who live in warm homes (Marmot Review Team, 2011).

- Diabetes, Kidney Disease, Neurological and Movement Disorders. Heat represents a particular threat for diabetes, who are more likely to be hospitalized or die prematurely during a heat wave or non-extreme summer temperatures, as well as those living with kidney disease, who are more likely to be hospitalized for or die from acute renal failure (Schwartz, 2005; Ostro et al., 2010; Semenza et al., 1999, Medina-Ramon et al., 2006; Naughton et al., 2002). Heightened risk for persons with psychiatric disorders or with movement disorders including Parkinson's have been documented.

Heat, Cold, and Social Isolation/Social Capital

In recent years, social and biomedical scientists, as well as clinicians, have paid increasing attention to the importance of social connections in fostering health. These connections are measured by means of a construct called social capital, which refers to the capacity of relationships with neighbors and community, through social contacts, shared knowledge, and behavioral norms to promote health, much as economic capital or assets can promote health. It is a way to measure the impact on health of the connectedness of civil society, or the extent to which people identify and relate positively with their neighbors and as part of their community; it is understood either in terms of the resources that people can tap as a result of the social group to which they belong or the network of social connections that enable them to gain access to resources (Kawachi et al., 2008). Social capital has demonstrated links to health outcomes (premature disability, ill health, and death have been tied to diminished social capital) as well as measures of well-being, just as other measures of physical and mental health have implications for health status.

In the case of access to residential electrical utility service, the key aspect of interest with respect to social capital is that of social isolation. The risk posed by social isolation during a heat wave is well-documented, for seniors and others who live independently with limited mobility (Astroma et al., 2011). Eric Klinenberg's case study of the Chicago heat wave of July 1995 identified social isolation of low-income

African American elders as a specific risk factor for hospitalization and premature death in the wake of extreme heat, compared with the lower mortality rates experienced by Latino elders of similar socioeconomic status who were less socially isolated by crime and who reported stronger networks of relatives and friends (Klinenberg, 2002). Persons who are socially isolated are at greater risk for adverse outcomes of exposure to temperature extremes.

APPENDIX 7: COMMONWEALTH EDISON AND THE AMI PILOT

To better understand the terms of the Commonwealth Edison AMI pilot, as well as the key aspects of residential utility electric service relevant to the HIA, this section offers a brief summary of Commonwealth Edison's billing practices, the cost-benefit assumptions made when planning AMI deployment, and the terms and findings of Commonwealth Edison's pilot related to dynamic pricing. ComEd delivers electricity to residential customers in northern Illinois, bills and collects bills, and provides customer service and is responsible for the reliable operation of its distribution system. However, ComEd does not own generation.[80] The ICC approves the method by which ComEd purchases generation supply power to meet the needs of its customers, but these purchases are conducted through contracts with wholesale market generators. ComEd passes through the cost of generation supply to its customers.

A typical ComEd customer receives one monthly bill that contains separate charges for delivery services and electricity supply services.[81] The distribution and delivery services provided by ComEd are regulated by the ICC and any rates charged by ComEd for those services, which remain a monopoly, must be approved by the ICC. A request for AMI deployment must be reviewed and approved by the ICC and the costs to pay for AMI will be reflected in rates charged to all customers. Since most customers are residential, most of the costs for AMI are typically included in residential rates, but commercial customers will also pay for part of any approved new AMI system.

ComEd customers pay a fixed monthly customer charge, and a usage-based (that is, priced by cents per kilowatt hour actually consumed) for the distribution or delivery function. ComEd also passes through a price for generation supply service based on contracts signed through the wholesale market. As of July 1, 2011, new rates for

[81] Taxes and other charges are included on customer bills in a separate section and billed on the amount of energy delivered to a customer.

ComEd delivery services went into effect.[82] The following chart shows the current prices for residential electricity service charged by ComEd as of July 2011:

DELIVERY CHARGES	Single Family Home		Multi Family Home	
	With Electric Space Heat	Without Electric Space Heat	With Electric Space Heat	Without Electric Space Heat
Customer Charge	$20.18	$14.28	$9.79	$7.22
Distribution Charge	$.01044 cents per kWh	$.01949 cents per kWh	$.01244 cents per kWh	$.02448 cents per kWh
ENERGY CHARGES	Summer		Non-Summer	
	With Electric Space Heat	Without Electric Space Heat	With Electric Space Heat	Without Electric Space Heat
Cost Per kWh	5.690¢	7.154¢	4.319¢	6.896¢

[82] See In Re ComEd Request for Increase in Delivery Services Rates, ICC Docket No. 10-0467, Final Order, May 24, 2011.

Energy supply costs are approximately 2/3 of a customer bill, and average customer consumption in Illinois for a single family home is 900 kWhs in the summer months of June, July and August, and 600 kWhs all other months. Using those averages, a single-family without electric space heat would have an average annual bill of $929 before other taxes and fees[83]:

- Customer Charge: $14.28 for 12 months = $171.36
- Distribution Charge: 8100 kWhs delivered over the course of the year charged at $.01949 per kWh = $157.87
- Standard Meter Charge: $2.86 for 12 months = $34.32
- Energy Supply Charge: Annual total of $565.54, consisting of:
  - 900 kWhs for 3 months at 7.154¢ per kWh = $193.16
  - 600 kWhs for 9 months at 6.896¢ per kWh = $372.38

Any additional costs imposed on customers to pay for AMI would increase customer bills beyond the normal rate increases that utilities need to operate their systems and bill and collect for services.

In 2007 in a proposal filed with the Illinois Commerce Commission (ICC)[84], ComEd proposed a system-wide investment in "smart grid" technology, of which AMI investments would be one part.[85] In ComEd's last delivery services rate proceeding, the utility requested approval of a cost recovery mechanism for deployment of "Systems Modernization Projects," a term which included a broad scope of "smart grid" projects.[86] CUB, along with other consumer advocates in the case, argued that although there may be significant benefits from smart grid technologies, those benefits will only be realized if the Illinois Commerce Commission (ICC) approaches smart grid planning strategically and with customers' best interests in mind.

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[83] Additional taxes and fees include, as of May, 2011, transmission services (.00760 cents per kWh), Illinois electric distribution charges (.00013 cents per kWh), environmental cost recovery adjustments (.00015 cents per kWh), energy efficiency program charges (.000160 cents per kWh), and franchise costs.

[84] The ICC regulates ComEd's prices charges to its customers, as well as the design of the prices and the costs or charges imposed on customers.

[85] ICC Docket No. 07-0566 – ComEd proposed a new program of "system modernization" investments based around general categories of proposed "smart grid" investments.

[86] ICC Docket No. 07-0566, available at http://www.icc.illinois.gov/e-docket/, Final Order, September 10, 2008 at pages

The ICC rejected the utility's proposal in favor of a test of the AMI technology in a pilot program[87] of at least 100,000 meters in an area demographically representative of ComEd's overall service territory. In order to ensure that the pilot program would result in information about AMI costs and benefits that could be used to evaluate any proposal for full scale AMI deployment, the ICC ordered that an AMI workshop process be initiated to develop project goals, timelines, evaluation criteria and technology selection criteria.

After a six-month workshop process, ComEd filed its AMI pilot proposal before the ICC. In October, 2009 the ICC approved a pilot which consists of approximately 100,000 meters in the Company's Maywood Operating Area (the I-290 corridor of the Chicago area composed of suburban communities) and 30,000 meters in the Chicago metropolitan area. ComEd began installation of the digital meters and associated two-way communication system in November 2009.

During the review of the proposed pilot program, the ICC also approved a smaller subset of the meters to be used as a test of dynamic pricing programs and home energy management tools (a "Customer Applications Pilot" or CAP). This test of approximately 8,000 residential customers is one of the largest in the country, and the only one of its kind to be designed as an "opt-out" test of dynamic pricing. Customers were randomly assigned to a new rate and provided with a variety of in-home devices and different pricing programs to test whether the particular program would result in overall usage reduction (conservation), lower usage during very expensive "critical peak" summer periods, and overall customer satisfaction with the technology and pricing program assigned. While customers could choose to leave the pricing program pilot at any point, they were not allowed to choose another pricing program or technology in preference over returning to standard utility service, creating what is known as an "opt-out" pilot. The purpose of this CAP was to determine if customers would change their usage behavior, i.e., use less overall or use less during certain peak pricing periods. If one or more of the pricing and technology options could be predicted to have a significant impact if operated on a full scale basis, these actions could result in lower electricity prices for all customers.

[87] ICC Docket No. 09-0263.

- The rates that the CAP tested included: An inclining block rate, where the customer pays more for each block of use – e.g. 7.5 cents for the first 100 kWh, 9.5 cents for the second 100, 12.5 cents for the third.

- A "critical peak price" which imposes a very high price for energy use at designated "critical peak" times, such as from noon until 5 p.m. Customers using electricity during those times are charged more than they are at all other times.

- A "peak time rebate" which does the same thing as a critical peak price but instead of charging more, customers who use less energy during peak hours receive a bill credit.

ComEd provided customers with in-home display units showing energy consumption and price, as well as programmable control devices to regulate home heating and air conditioning systems. In addition, ComEd solicited pilot customers to go to their account on the ComEd website and view their usage information in more detail and learn how to respond to the specific pricing program that the customer was enrolled in.

COST BENEFIT ASUMPTIONS FOR AMI DEPLOYMENT

To estimate the bill impact of AMI on residential customer bills, the following information needs to be provided:

- The time period over which costs are going to be recovered. Capital investments are amortized over their useful life, and utilities earn a return on those investments. AMI meters, communications equipment, etc. would be considered part of ComEd's "rate base," which earns a return. As of July 1, 2011, ComEd earned a return of 8.51% on its original cost rate base of $6,548,591,000.[88]

- What percentage of the capital costs are assigned to the residential class and what the amortization period and associated depreciation rate is for the

[88] ICC Final Order, Docket No. 10-0467, at 315-316.

capital costs, and finally the number of customers in each customer class. Given that ComEd has four residential delivery service classes, the breakdown between single and multi family homes, and then those with and without electric space heat must also be considered.

For the purposes of our HIA Report, the principals have assumed that bill impacts for residential customers for all AMI related costs would fall into the same range as other utilities, i.e., $2-3 dollars per month.

Black and Veatch, ComEd's independent consultant, which assessed the operational impact of AMI deployment based on the pilot data, used a 20-year analysis period to calculate costs and benefits, which the evaluation report notes is discretionary. Estimating costs and benefits over a longer period means the cost assumptions become increasingly speculative. Given that technology changes over time, it is likely that technology will improve, and provide more capabilities at potentially lower or higher prices in future years. The final report includes a sensitivity analysis of some of the key assumptions to determine the impact of alternative assumptions on the final result, in this case, the impact on the base case of independent changes in nine key variables.

Variable	Base Case Value	Sensitivities Noted Description and Rationale
Energy and Delivery Prices	An average 3.7% escalation each year.	Future Energy and Delivery services prices ComEd charges its customers have the largest impact on the estimated Benefits since the UFE, CIM, and Bad Debt benefits (avoided costs) are all calculated based on these prices. This change would result in an unfavorable impact to the business case relative to the Base Case.
AMI Meter Price	$122.78 / meter with no escalation during the deployment.	Meter prices are the largest single contributor to capital costs and may fluctuate. However, the unit price uncertainty is low and vendors are willing to lock in the unit price for the duration of the project. Digital meter prices have dropped since their introduction, which suggests there is a bias toward more favorable prices with scale and learning effects in manufacturing, and competitive market pressures as the market grows and matures.
UFE (Total Realizable Benefit)	50%	Based on ComEd analysis, the model assumes 0.9% of total distribution system dispatch is UFE, and that 50% of this is reducible with AMI (i.e., can be avoided and therefore estimated as a benefit).
CIM (Percent Billable Consumption)	100% Billable (Energy & Delivery)	The base case assumes 100% of the customers who are directly accountable for the current CIM losses (kWh and $) become billable and pay their ComEd bills after AMI is implemented and CIM is eliminated. The business case will be impacted if all of these customers instead opt to simply not consume the energy they do today. In this case, ComEd would still recognize an avoided power purchase cost, but would not get the benefit out of the delivery services charges.
Reduction of Bad Debt (Remote Connect / Disconnect)	$30.5M	An estimated $30.5M in Net Bad Debt Expense can be avoided with use of Remote Connect/Disconnect Switch and associated new business practices to manage bad debt. A component of this benefit depends on customer behavior and specifically customer payment and re-connect choices given new knowledge of ComEd's remote switch capabilities. The sensitivity analysis evaluates both a favorable and unfavorable value to this particular estimated benefit.
AMI Meter Installation Cost	$40.48 based on actual pilot costs and experiences.	The sensitivities suggest potential cost reductions due to the pilot costs reflecting only cold weather installations, the limited deployment period (reducing the learning curve benefit) and other lessons learned related to elimination of meter installation inefficiencies. An increased installation cost could be realized as a result of significant personnel movement and changes within the installation group causing inefficiencies, increased training costs and other associated overhead.
"Door Knock" Customer Notification Process (on Remote Disconnection for non-pay)	No Knock Required to Disconnect	Given the current "Part 280" rewrite, the disconnection rules are being rewritten to clarify the business process for disconnecting meters for non-payment using technology. ComEd does not know whether an on-premise contact (i.e., "door knock") will be required immediately prior to disconnection. Since the pending new process is uncertain, the additional costs associated with it cannot be estimated. Black and Veatch estimated the impact of having a "door knock" required in at least 50% of the circumstances where customers are disconnected.

Customer Applications and Pricing Programs

ComEd's Customer Application Pilot (CAP) was conducted from June 2010 through May 2011 with approximately 8,500 customers randomly selected from those who received a new smart meter. CAP customers were asked to participate in a pricing and technology pilot on an "opt-out" basis, that is, customers were enrolled in the CAP and only removed upon request. The experience from other similarly constructed pilots suggested that recruiting volunteers would require several months, result in high costs, or both, to achieve the participation level required to produce statistically significant results. Conversely, an *opt-out* deployment could be accomplished in relatively short order, and possibly at a lower cost. Moreover, the traditional *opt-in* recruitment process results in all participants being volunteers. Extending results to the entire population as a whole is not straightforward, because it requires establishing what distinguished volunteers and a way to identify them in the general population and the likely enrollees in a full-scale roll-out of the applications. Because opt-in customers are representative of the population, the pilot results can be used to make inferences about the full population impacts, as long as the drop-out rate is low.

The CAP tested customer use of five different rate applications with a variety of in-home devices, such as in-home displays and programmable thermostats. The pilot also tested customer response to educational and promotional strategies designed to stimulate customers to visit ComEd's website to see more detailed usage information and to use the combination of the pricing plans and in-home technologies to (1) shift usage from high cost peak periods to lower cost off-peak periods and (2) reduce overall consumption of electricity.

The five rate options tested include:

- Day-Ahead Real Time Pricing (DA-RTP), which changes the price of electricity supply through a new hourly price schedule issued each day.
- Combination of DA-RTP with critical peak prices in which the customer is either charged a very high price for usage during critical peak events (CPP) or provided a rebate or credit for reducing load during these critical peak events (PTR). Combining RTP with event-specific prices whereby the price of electricity increases to $1.74 per kWh over the RTP price (critical peak pricing) or the customer is paid $1.74 per kWh for load reduced during the event (peak time rebate).

- Time of Use, where the price is changed twice daily.
- Inclining Block Rates (IBR), where the more a customer consumes the more expensive the price per kWh is.
- For the CPP, RTP, PTR, and TOU rates, the peak period was defined as 1:00 - 5:00 p.m. weekdays.

All participants were invited to sign-up for an "eWeb service" that provided access to detailed information about billing data. Selected participants had access to basic or advanced in-home displays (IHD) which continuously displayed information about household electricity consumption,[89] a web-based information system, and to the means for regulating their household thermostat at times when load relief is needed through a programmable and controllable thermostat to facilitate adjusting load to price changes.

[89] The simple IHD continuously displays information, extracted directly from the AMI meter, about household electricity usage, both the current rate of energy usage and a historical comparison. Pilots that deployed this technology report a wide range of customer responses, from no change to a 5% or greater overall reduction in electric consumption. The advanced IHD incorporates electricity usage information into a device that serves a variety of roles including internet access.

These combinations of pricing programs and technology options resulted in 27 treatment cells and control groups, shown below:

		Enabling Technology Type[2]				
		None	Enhanced Web (eWeb)	eWeb + Basic IHD	eWeb + Advanced IHD	eWeb + PCT/IHD (AIHD/PCT)
Flat Rate Type (1,650 Customers)	Flat Rate Existing Meter No Education	Control Group F1				
	Flat Rate Existing Meter Education		Application Group F2 (225)			
	Flat Rate AMI Meter Basic AMI Education		Control Group F3 (225)			
	Flat Rate AMI Meter Education		Application GroupF5 (225)	Application Group F6 (300)	Application Group F7 (225)	
Energy Efficiency Rate Type (750 Customers)	IBR Rate AMI Meter Education		Application E1 (225)	Application E2 (300)	Application E3 (225)	
Demand Response Rate Type (3,525 Customers)	CPP/DA-RTP AMI Meter Education		Application D1 (750)	Application D2 (525)	Application De (525)	Application D4 (525)
	PTR/DA-RTP AMI Meter Education		Application D5 (225)	Application D6 (525)	Application D7 (225)	Application D8 (225)
Load Shifting Rate Type (2,625 Customers)	DA-RTP Rate AMI Meter Education		Application L1 (450)	Application L2 (525)	Application L3 (225)	
	TOU Rate AMI Meter Education		Application L4 (225)	Application L5 (750)	Application L6 (450)	
Total Customers: 8,550		*450*	*2,550*	*2,925*	*1,875*	*750*

EPRI was selected by ComEd to do an independent evaluation of the Consumer Applications Pilot (CAP), and EPRI issued a preliminary report on April 5, 2011[90] and a final analysis in October 2011.[91] EPRI's reports presented findings on whether customers who were put on a variety of dynamic pricing programs and offered in-home technology options modified their energy usage and consumption patterns during the pilot which was operated from June 2010 through May 2011. As an initial matter, EPRI identified some issues relating to the implementation of the pilot which in turn affected EPRI's ability to draw conclusions about how ComEd customers would respond to these pricing programs and technologies:

- *Pilot Demographics:* EPRI found that the "load research sample," which in the pilot was the estimated 7,000 customers, acting as the control group was found not to be representative of the residential customers located in the pilot area. For example, high usage customers were overly represented in the load research sample, with a usage level almost double the usage level of the rate treatment customers. As a result, it was not possible to give a statistically valid comparison between pilot customers and ComEd residential customers generally. Other data gathering impediments were experienced with the evaluation of the Inclining Block Rate ("IBR") option (which required at least five years of historical usage data to create long term average usage levels from which the breaks or usage blocks of the IBR could be constructed so that IBR customers over-represent high usage and under-represent low usage customers) and the difficulties in evaluating a valid sample of customers with in-home technologies (which could not be placed in higher floors of multi-unit residences due to radio signal transmission difficulties, so that treatment cells involving in-home displays under-represented low usage customers because they exclude customers in multi-family residences above the first floor of a residential building).

[90] The Effect on Electricity Consumption of the Commonwealth Edison Customer Application Program Pilot: Phase I, EPRI, Palo Alto, CA: 2011, 1022703. ComEd selected EPRI to conduct the evaluation of its pilot program.

[91] The Effect on Electricity Consumption of the Commonwealth Edison Customer Application Program Pilot: Phase 2 Final Analysis EPRI, Palo Alto, CA: 2011, 1023644 (October 2011).

- *Data Gathering*: While after 3 months only 2% of those enrolled opted out,[92] over 1,000 participants were no longer part of the pilot at the end of the time period because the customer moved or cancelled their ComEd account during the pilot period. In addition, approximately 1,600 of the 8,000 enrolled customers were excluded from the analysis because more than 2% of the usage entries from June through August were recorded as zero and the failure to obtain the data was not explainable by outage. Because the summer of 2010 was considered cool, only a total of six critical peak event days were called in July and August, whereas during a summer with more very hot days more critical peak event days would likely be called.

Overall, EPRI found that none of the treatment cells (combinations of pricing and technology options) demonstrated a statistically valid overall usage reduction or a statistically valid peak load usage reduction. As a result, ComEd could not verify any of its hypotheses that the various pricing programs coupled with the various in-home technology options would result in a statistically valid change in customer usage behavior. However, there were a small group of customers (approximately 10% of the participating customers with valid data) in some treatment groups that did respond even if the treatment group as a whole did not respond. EPRI found that 6.7% of CPP and 4.9% of PTR customers reduced event-period load by 32% to 37% in five of the six price change events occurring throughout the summer, when prices reached $1.70 per kWh. This was determined to be primarily due to responders shifting load from the event period (1:00 to 5:00 p.m.) to other times of the event day, since EPRI found little evidence of overall energy conservation. Of the participants on a regular real-time price, DA-RTP, 8.7% participants reduced usage during hours of high prices though their overall usage during the day increased an average of 7% on event days. These participants exhibited a higher price responsiveness according to the "substitution elasticity value" than the CPP and PTR customers, though the percentage of load change was not as significant as CPP and PTR customers.[93] Usage patterns among both CPP and PTR customers showed increased usage after the event

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[92] The pilot "rules" provide a bill protection feature for all customers, but this feature was not promoted and it was used primarily as a means of retaining customers who sought to opt out.

[93] EPRI concludes this was due in part to prices under the DA-RTP program being not nearly as high as the CPP or PTR prices.

and pre-cooling prior to the event (which is communicated to customers the previous day).

By comparison, only 2.7% of flat rate customers responded, 2.9% of IBR customers, and 4.2% of TOU customers. Moreover, the IBR rate induced no significant difference in monthly usage in the summer of 2010. A comparison of the load impacts across price and enabling technology applications did not reveal statistically significant effects attributable to TOU or to any of the enabling technology applications coupled with the pricing applications. However, at the end of the three months, only 10% of the applications had been installed or were working correctly. For other rate treatments, such as time-of-use (TOU) rates, EPRI noted it may take customers more than three months to become acclimated and respond to a change in price.

Finally, EPRI noted there was a very low uptake on the in-home devices. Less than 10% of the programmable thermostats that were intended were in fact installed. As a result, the impact of these devices on customer response to CPP and PTR is obscured. Very few customers purchased in-home devices; only 2% who were offered the device for a fee purchased it. Other customers were offered the in-home device at no additional charge, and of those, 34% installed the basic in-home display and 13% installed the advanced in-home display.

In its Final Report, EPRI included some information on demographic characteristics of the pilot customers based on the responses of two surveys conducted during the pilot, the first in March 2010 during the enrollment process and the second after the pilot was completed during April-June 2011. Customers who completed the final survey were given a $50 credit on the ComEd bill. ComEd received 2,423 responses to the final survey, one-third of the eligible CAP customers, i.e., those enrolled in CAP as of April 2011 just prior to the end of the pilot. The survey results documented that customer satisfaction with their pricing plan was in the range of "average" (overall score of 5.6 with 0 as "extremely dissatisfied" and 10 as "extremely satisfied"), and in all pricing options, satisfaction levels were lower than satisfaction with ComEd overall as their utility.

While EPRI's Final Report presents a table of the variety of demographic traits of the customers who returned the survey, the Report does not present any information on the response to the various treatment options by demographic characteristics, e.g., age, size of household, income, and housing type. However, the Report does confirm that there is little demographic difference between the survey customers who responded to the pricing programs (the 10% who did respond) and those who did not respond to the pricing programs.[94] Finally, EPRI's Final Report concludes, "An opt-out recruitment strategy by itself does not appear to encourage a greater treatment response level than opt-in pilots report."[95]

An analysis of the AMI pilot conducted for ComEd by Black and Veatch estimated that 30,000 MWh of electric generation would be avoided from customer energy efficiency or other voluntary use reductions, after full deployment of AMI to all ComEd customers.[96] This is a very small amount of energy savings (0.03% of ComEd's total of 91.1 million MWh in sales in 2010).[97]

This energy savings translates to an estimated CO2 reduction of 23,000 tons per year.[98] Avoided vehicle emissions of 4 million miles of travel were also reported; this translates to an annual reduction of about 2,000 tons of CO2 emissions.

The lack of observable energy savings in ComEd's AMI pilot is inconsistent with similar demonstrations, including the 2003-2006 Energy-Smart Pricing Plan in ComEd's service territory which showed a 3-4% reduction in summer electricity usage.[99] This difference may owe to pricing incentives and/or inadequate information provided to AMI pilot participants and should be further examined.

The combined reduction in CO2 emissions of 25,000 tons per year, derived from Black and Veatch's estimates of the benefits of full AMI deployment, would be roughly equivalent to the annual CO2 emissions from roughly 4,400 passenger vehicles or the energy consumed in 2,000 homes.[100] For comparison, the Chicago metropolitan area's total CO2 emissions have been estimated to be about 40 million

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94 EPRI Final Report, Table 6-4, page 6-11.

95 EPRI Final Report, Abstract, at vii.

96 Section 14.1.

97 Greater - but still modest - reductions in consumption are attributed to reducing unaccounted for energy (UFE, 350,000 MWh annually). We do not consider these energy savings to result in actual emission reductions because as discussed in Section 7.9 of B&V report, most customers found to be receiving unmetered power are expected to begin paying for power.

98 Using Black and Veatch's CO2 emission factor in Section 9.5

99 A. Faruqui and S. Sergici, "Household response to dynamic pricing of electricity: a survey of 15 experiments," J. Regul. Econ. (2010), 38, 193-225.

100 http://www.epa.gov/cleanenergy/energy-resources/calculator.html

tons.[101] Reductions in other pollutants including nitrogen oxides, carbon monoxide, mercury, particulate matter and volatile organic compounds would also be expected but were not calculated here due to the lack of project-specific data on energy consumption.

101 2005 emissions, as reported in: Center for Neighborhood Technology, "Chicago's Greenhouse Gas Emissions: An Inventory, Forecast And Mitigation Analysis For Chicago And The Metropolitan Region," (2008); available at http://www.cnt.org/repository/CNT_Climate_Research_Summary_9.17.08.pdf

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