Ameren Illinois Company's
Response to ICC Staff Data Requests on Rehearing
Docket No. 12-0244
AIC's Advanced Metering Infrastructure Plan
Data Request Response Date: 8/17/2012

DAB 3.01

Please refer to lines 81-84 of Ameren EX. 5.0 RH. That testimony indicates that the iGrid model "has been successfully used in analyses such as the one presented with" Dr. Faruqui's testimony.

1) Where was the iGrid model used?
2) Please define "successfully used."
3) Has Dr. Faruqui or employees of the Brattle group compared the iGrid predictions of benefits to actual benefits observed in the areas where the iGrid model was "successfully used?"

RESPONSE

Prepared By: Ahmad Faruqui, Ph.D.
Title: Principal, The Brattle Group
Phone Number: 415-217-1000

1) The *iGrid* model has been used for two utilities, one energy efficiency firm, and the Institute for Electric Efficiency (IEE). The only publically filed use of the model was for the Institute for Electric Efficiency.
2) The *iGrid* model has produced forecasts that have helped inform the clients' decision making. Elsewhere, we have used the model to illustrate benefits at the national level and for a hypothetical utility. Results have been presented at a variety of conferences in both the United States and abroad.
3) The iGrid analysis is a forward-looking, prediction-generating model that informs clients' decisions on whether or not to implement various programs. Actual program implementation and benefits take years to be realized. For that reason, it is premature to empirically validate *iGrid's* projections.

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DAB 3.02

Dr. Faruqui indicates on lines 151-162 of page 7 of his testimony that annual benefits and costs per participating customer and the number of participating customers must be provided in order to compute aggregate impacts of each program.

1) For each program to which Dr. Faruqui refers, how were annual benefits and costs per customer determined?
2) For each program to which Dr. Faruqui refers, how were the number of participating customers determined?

RESPONSE

Prepared By: Ahmad Faruqui, Ph.D.
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1) **Costs**
The per-customer costs are incurred in the year in which customers join each of the programs included in the analysis. In prior work for the Institute for Electric Efficiency, we had developed cost estimates for the enabling technologies. We polled a small group of experts to update these estimates, both to reflect current market conditions and future market conditions. Given that these technologies are based on digital electronics, we project costs will decline significantly over the next two decades, in consort with the type of technological innovation that normally occurs in digital technologies and due to economies of scale. In 2012, we estimate that an IHD (or equivalent display in a small business) will cost $50 nominal dollars, a PCT will cost $150, and a Home (or Business) Energy Management System will cost $400. A $300 per kW installed cost was used for the CPP+ADR program. The cost of installation is included in these price estimates. It is widely expected that owners of electric vehicles will have to pay an electric vehicle premium, since PEVs are more expensive than conventional vehicles. However, this premium is expected to decline with time. We assume the premium is $9,500 in 2012. This value was based on consultations with technical experts and a review of the automotive literature. An example of this literature is Deutsche Bank's 2008 study entitled "Electric Cars: Plugged In-Batteries must be included," which can be found at http://www.inrets.fr/fileadmin/recherche/transversal/pfi/PFI_VE/pdf/deutch_bank_electric_cars.pdf. Other examples include market price data from a number of industry publications such as Auto Trader, Edmunds.com, and the websites of various automobile manufactures. The Brattle Group considered comparisons of current prices of PEVs and CVs of similar qualities when determining the price premium. For example, the prices of

the Chevy Volt electric vehicle and the Toyota Prius PHEV were compared to similar models of vehicles made by their respective manufacturers.

In the first ten years of the forecast, nominal technology costs decrease at a rate of 16% per year. In the next ten years, the costs decrease at a rate of 8% per year.

Benefits

We use five categories of benefits: avoided generation capacity costs, avoided distribution capacity costs, avoided transmission capacity costs, avoided energy costs, and avoided carbon costs. In the case of PEVs, a sixth category of benefits arises in the form of avoided gasoline costs. For each program, per customer benefits come from peak reduction and energy reduction at the meter.

Total avoided energy costs per customer in a given year are calculated by multiplying the energy reduction per customer (MWh) at the meter into the avoided energy cost ($/MWh). The total avoided capacity costs per customer is found by multiplying the change in peak demand per customer (MW) into the avoided capacity cost ($/MW).

The per customer avoided carbon cost equals the avoided carbon emissions per customer (metric tons) times the carbon price ($/ton) in the corresponding year. Avoided carbon emissions are calculated by multiplying the energy reduction at meter per customer into the carbon factor (metric tons of CO2 per MWh of generation). We assumed that on average, there are 0.8 tons of carbon emitted per MWh.[1] This value is used to quantify the expected reduction in carbon emissions that follows from a result of lower energy consumption that arises from EE programs.

For the electric vehicle calculations, we quantify the change in carbon emissions in the peak and off-peak periods as well as the change in carbon emissions due to less gasoline usage. The peak hour emissions rate is assumed to be 0.7 metric tons of carbon per MWh and the off-peak rate is 0.9 metric tons. These assumptions are based on the assumption that off-peak generation is 100% coal and on-peak generation is 50% coal and 50% gas, and they are consistent with the average MISO estimate. Gasoline also has an associated emissions rate. We assumed that there are 20 pounds of carbon emitted per gallon.

Gasoline benefits per customer were calculated by multiplying avoided gasoline consumption (gallons) into the gasoline price by year. The avoided gasoline consumption for each year was found by subtracting the total gasoline consumed under the PEV scenario from the total amount of gasoline consumed by a customer under the No PEV scenario.

Forecasted avoided capacity costs and avoided energy costs in each year over the 20-year time period were provided by Ameren. The price of carbon, which was also provided by Ameren Illinois, is assumed to be zero until 2025, at which point it is $30 in nominal terms. We used predicted gasoline prices obtained from the U.S. Energy Information Administration's Annual Energy Outlook 2011 report.

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[1] This assumption is based the 2016 forecasts for generation and CO_2 emissions in the 2011 MISO Transmission Expansion Plan.

The assumptions regarding the per-customer impacts of each program for Residential and Small C&I customers are shown in Ameren Exhibit 5.4RH. These CPP and PTR assumptions are based on Brattle's *Arc of Price Responsiveness* database, which summarizes the relationship between demand response and the peak to off-peak price ratio as observed in more than a hundred pilot programs. In this case, we assumed that Ameren Illinois customers will be offered a CPP rate with an 8:1 price ratio (consistent with the assumption in the report published by the FERC Staff in 2009, A National Assessment of Demand Response Potential, which is referenced below) and that the PTR will offer an equivalent price ratio. Based on the relationships contained in the Arc, the expected peak reduction would be 18% with no enabling technology, 22% with a PCT device, and 45% with a Home/Business Energy Management System.

The DLC reduction is based on the assumption that DLC usually produces a 1 kW reduction, and 30% of DLC devices usually fail. With AMI, those 30% will be detected sooner and can be fixed, yielding a benefit of 0.3 kW (or 9%) per customer. The PSP reduction is based on Navigant's evaluation of the PSP program, which found a per customer reduction of roughly 0.5 kW or 15%. Residential and Small C&I customers are also expected to reduce their daily energy usage as a result of being on dynamic rates with and without enabling technologies. The amounts are based on assumptions used in previous Brattle work for the Institute for Electric Efficiency.
The peak reductions for these C&I customers are assumed to be 7% with the CPP rate alone and 14% with CPP plus Automated Demand Response. These assumptions are based on the 2009 FERC DR Assessment. There are no energy savings associated with CPP or CPP with ADR.

In the PEV scenario, in any given year, the total miles driven by PEVs equals total miles travelled in Illinois multiplied by the share of the Illinois population that lives in Ameren territory and which has AMI multiplied by the PEV penetration rate. To get the amount of gasoline used, we assumed that only 66% of miles driven by a PEV are powered by electricity, with the remainder powered by gasoline. We thus multiplied the PEV miles driven by 0.34 (34 percent on gasoline) and then divided by the fuel economy number (miles per gallon) to get gasoline consumption. The remaining miles are driven by conventional vehicles and hybrid vehicles. The combined fuel economy is calculated by multiplying the projected fuel economy of conventional vehicles and hybrids by their respective share of the vehicle fleet (excluding PEVs). The gasoline consumed is therefore the driving distance by conventional and hybrid vehicles divided by their combined fuel economy. All projected fuel economy numbers are calculated using data from an Electric Power Research Institute's 2007 paper entitled, "Environmental Assessment of Plug-In Hybrid Electric Vehicles Volume 1:Nationwide Greenhouse Gas Emissions."

2) Participation rates in the DR and EE programs described above are laid out in Ameren Exhibit 5.3RH. For the Residential class, 10% of customers with smart meters will enroll in Power Smart Pricing (PSP) by 2032. These do not include the existing PSP participants; instead, this percent represents the customers that will participate in PSP due to AMI. We assume that 1.3% of Residential customers with smart meters will enroll in a CPP rate without enabling technology, with another 0.7% participating in CPP with an IHD, another 0.7% participating in CPP with an IHD and PCT, and another 0.3% participating in CPP with a HEMS and PCT. In total, 23.3% of Residential customers with smart meters will be on a PTR rate, again with some of those with IHDs and some

with both IHDs and PCTs. We assume that 0.8% of the population will have TOU and HEMS to allow them to smart charge their electric vehicle. Another 2.9% will be on a DLC program. That leaves 60% of Residential customers who have smart meters but are not on any DR or EE program.

For Small C&I customers, we assumed that 2.9% of the population will be on a CPP rate and 2.9% will be on a DLC program, which are the same assumptions that we made for the Residential class. Again, some of the customers on the CPP rate also have displays and PCTs. However, the Small C&I customers will not have the option to join PTR, PSP, or TOU. For Medium and Large C&I customers, we assumed that a total of 3% will be on a CPP rate, roughly half with Automated Demand Response. Finally, we assumed that Very Large customers will have double the participation rates in CPP as do the Medium and Large customers.

For the baseline scenario for PHEV adoption, we assume that among AMI enabled residential customers, 0.8% of vehicles by 2032 will be PEV attributable to AMI. That is equivalent to 0.7% of the entire vehicle fleet of AMI enabled customers. Since we are unaware of any existing data showing how sensitive PEV sales are to electricity prices, we have derived this estimate by analogy, by examining the relationship between the sales of hybrid electric vehicles and gasoline prices. Like PEVs, these vehicles sell at a premium, but have lower costs per mile driven. Recent scholarly research using hybrid vehicle sales in the period 2000 to 2006 showed that as the price of gasoline increased by 1%, the quantity of fuel efficient hybrid vehicles sold increased by 0.86%.[2] We have used this relationship to estimate the sensitivity of PEV sales to electricity price. Recent models of PEV charging costs show that dynamic rates can allow consumer savings of 35 to 64% over charging under flat electricity rates.[3] To be conservative, we use a savings rate of 23%, which is two-thirds of the lower bound of the estimated savings rate. Plugging this vehicle charging price change into our model, we get that a 23% reduction in price will lead to a 20% increase in PEV sales. Using the same EIA estimates of future oil prices that we use elsewhere in our model, Becker, Sindhu & Tenderich estimate that PEV's will constitute 24% of the light vehicle fleet in 2030.[4] We halve this number to better reflect PEV penetration predictions filed with the ICC in 2010 by Ameren Illinois.[5] In Illinois light vehicles accounted for 90% of all vehicle miles traveled in 2010.[6] Thus we can say that approximately 11% of the entire fleet in 2030 will be PEVs. If lower charging prices enabled by AMIs leads to a 20% increase in PEV sales, then this sums up to a 2.1% PEV share of all vehicles attributable to AMI. Erring on the side of caution,

[2] Gallagher, Kelly S. & Erich Muehlegger (2011): "Giving green to get green? Incentives and consumer adoption of hybrid vehicle technology", *Journal of Environmental Economics and Management*, Vol. 61, Issue 1, pp 1–15.

[3] Faruqui, Ahmad, Ryan Hledik, Armando Levy & Alan Madian (2011): "Smart Pricing, Can time-of-use rates drive the behavior of electric vehicle owners?," *Public Utilities Fortnightly,* October 2011, pp.38-45.

[4] Becker, Thomas, Ikhlaq Sidhu & Burghardt Tenderich (2009): "Electric Vehicles in the United States: A New Model with Forecasts to 2030", Center for Entrepreneurship & Technology (CET) Technical Brief, available online at http://cet.berkeley.edu/dl/CET_Technical%20Brief_EconomicModel2030_f.pdf

[5] Ameren Illinois (2010): "Ameren PEV Assessment Report", available online at http://www.icc.illinois.gov/electricity/pev.aspx

[6] Illinois Department of Transportation (2011): "Illinois Travel Statistics", available online at http://www.dot.state.il.us/travelstats/2011_ITS.pdf

we halve this number again, and then reduce it by one-third to get to the baseline case, which has a PEV penetration among AMI customers of 0.7%. If we attribute this entirely to residential customers, the residential participation rate among AMI enabled customers is 0.8%, as shown in Ameren Exhibit 5.3RH.

For all programs, we assumed that participation in each program starts at 0% in 2016 and follows the "S" curve growth pattern that is commonly found in the literature on market diffusion to reach the targets described above by 2032.

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The question and answer beginning on line 177 and ending on line 201 of Dr. Faruqui's testimony (Ameren EX. 5.0RH) mentions increased savings from devices such as in-home displays. Is Dr. Faruqui aware that the evaluation of the ComEd Customer Application Pilot, approved in ICC Docket No. 09-0263, found a statistically insignificant change in usage by customers who had an in-home device?

RESPONSE

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Yes, Dr. Faruqui is aware of this evaluation. Elsewhere, statistically significant results have been found. Please see the study entitled, "The impact of informational feedback on energy consumption-A survey of the experimental evidence."[7]

[7] Faruqui, Ahmad, Sanem Sergici & Ahmed Sharif (2010): "The impact of informational feedback on energy consumption-A survey of the experimental evidence," *Energy*, July 2010, pp.1598-1608.