The Smart Grid at AmerenUE

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AmerenUE – Smart Grid Strategy & Implementation

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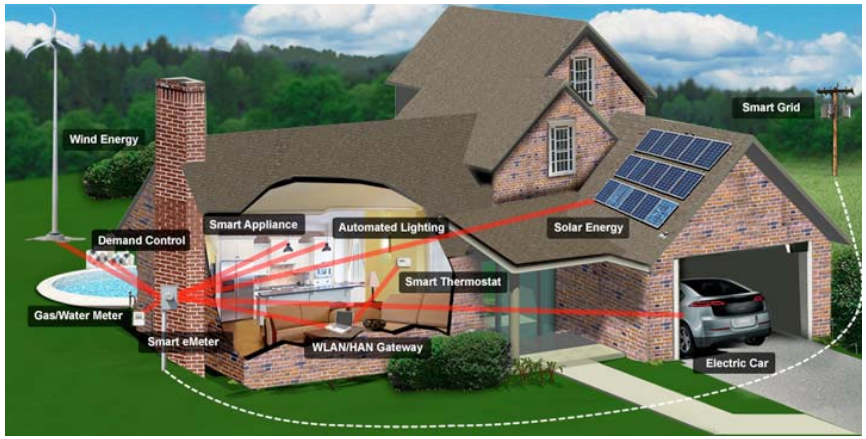
AmerenUE's Smart Grid Strategy

Our Vision – Leading the Way to a Secure Energy Future

- Our Smart Grid strategy – "*Transform AmerenUE's grid to create a secure, reliable and more efficient infrastructure enabling customers' use of 'energy smart' technologies"*

- AmerenUE's investments today are focused on the continued pursuit of ***service reliability***, ***operating efficiency***, and ***asset optimization***, and on building a ***secure, robust energy delivery infrastructure*** as a means of enabling the elements of the Smart Grid being discussed today

- Presentation will address the workshop agenda topics individually with tie-ins to UE's Smart Grid strategy



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AMR vs. AMI Metering

Overview of Current and Future Deployment

- ***Automated Meter Reading (AMR)*** is characterized by one-way communication with the meter (meter → utility), while ***Advanced Meter Infrastructure (AMI)*** features two-way communication

- AmerenUE has been 100% deployed with AMR since 2000:
  - 1.2M meters in total, all owned by AmerenUE
  - 18,000 configured for time-of-use/demand reporting and 5,000 configured for 15-minute interval reporting – industrial and large commercial customer use
  - The rest report daily kWhrs – residential and small commercial customer use

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AMR vs. AMI Metering (cont'd)

Overview of Current and Future Deployment

- In September 2009, AmerenUE conducted a study comparing the costs and benefits of AMR vs. AMI and concluded the following:
  - AMR achieves most the of operational benefits of AMI without the two-way communication – automatic "reads," outage notification, tamper detection, system load data
  - The operational benefits offered exclusively by AMI include remote connect/disconnect and remote meter programming/configuration
  - Conversion to AMI would require new meters, a new communication infrastructure, a new operating system, and billing system integration – a total conversion is estimated at over $300M
  - *The benefits of AMI do not outweigh its costs today* – we are closely monitoring other AMI deployments, with plans to revisit this issue

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AMR vs. AMI Metering (cont'd)

Estimated Meter Life and Technology Obsolescence

- Electronic meter manufacturers estimate their products have ***15-20 year operating lives*** – our field experience is consistent with this
- AmerenUE's meter replacement numbers vary annually, based on sample test guidelines and meter analytics, diagnostic reporting
- New "smart" (AMI) meters do allow for remote reconfiguration as means of upgrading firmware without changing the meter
- Uncertainties exist around whether impending security and interoperability standards will require meter replacements or not – these uncertainties, combined with our low fixed rates, no real-time pricing drivers, and unknown customer benefits support UE's deferring a move to AMI

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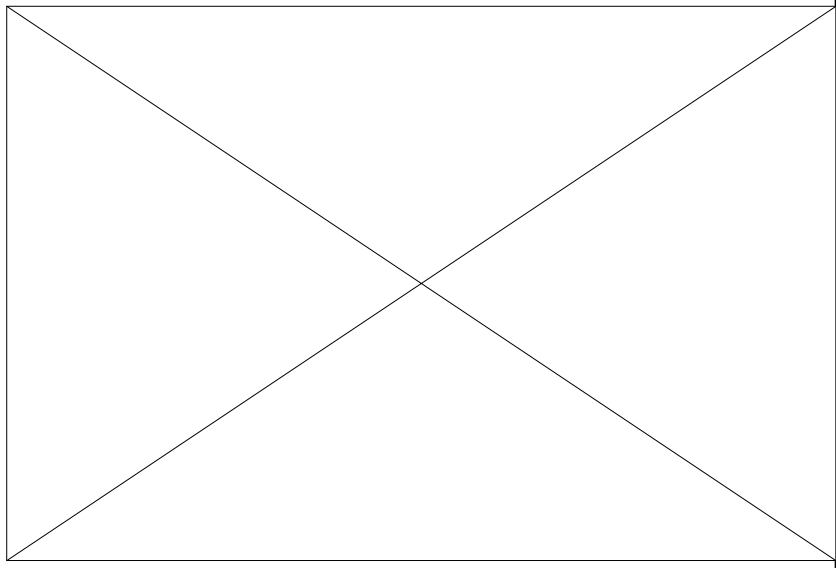
PURPA Section 111(d)(19)

Current Deployment and Plans for Customer Info

- Section 111(d)(19) deals with providing customer access to energy usage and pricing information, primarily in time-based pricing markets – real-time pricing information not applicable to MO retail customers as no structure exists
- Despite this, AmerenUE provides residential customers access to their daily kWhr usages via the AmerenUE website – supplemented by Personal Energy Report mailings
- Time-of-Use rates available across all customer classes from industrial to residential
- All retail rates available for viewing on tariff sheets posted on website



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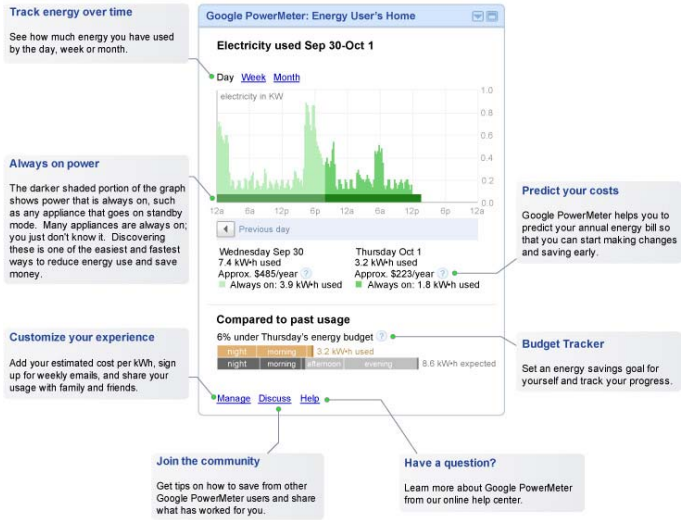
Google PowerMeter

Impact of PowerMeter Software for Customers and IOUs

- Software that provides an Internet user interface for customers to analyze the effects of and costs associated with their energy usage
- Customers can register with Google and purchase own monitoring and communication hardware (beginning at $200) or register with local utility provided they have smart meters and are Google partners
- Two IOU partners in US to date – San Diego Gas & Electric and Jacksonville Electric Authority
- *Potential impact is unclear* – this is just one of multiple vendor options available today for Internet display of customer information that UE is investigating



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Smart Appliances

Overview, Current Role and Schedule of Availability

- Association of Home Appliance Manufacturers says a “smart” appliance must: respond to utility pricing signals, auto “shed” or reduce usage based on programmed preferences, provide for manual override, operate as part of a Home Area Network, and be able to shift usage in favor of renewable sources

- US household smart appliance market expected to grow to $5.5B from 2011-2015 – clothes washers & dryers, refrigerators, and dishwashers (GE and Whirlpool leading) – seen as making the most tangible difference in customer education about Smart Grid benefits

- *Real-time pricing structure is key driver,* else these units are merely “energy efficient” as opposed to “smart” – hence the potential for a MO market is unclear today

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Plug-In Hybrid Electric Vehicles

Current Installed Provisions and Future Provisions

- Auto industry has already standardized on 120V and 240V charging characteristics and the plug-in connectors (i.e. “interfaces”)
- AmerenUE taking receipt of two plug-in hybrid bucket trucks in 2011 as part of EPRI demonstration project
- Participating with St. Louis Clean Cities on Plug-In Readiness Task Force as a means of monitoring initial discussions on how to create local market for new PHEVs
- August 2009 technology study conducted – no significant system effects anticipated until PHEV penetration in service territory approaches ~150K vehicles

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Voltage Regulation

Role of Regulation Technology and Equipment

- Responsible voltage regulation begins with ***line loss minimization*** in order to "flatten" feeder voltage profiles – *line capacitors do this*

- ***Volt-VAR Optimization (VVO)*** – refers to the subsequent reduction of system voltage on these "optimized" feeders as an energy conservation measure (while respecting voltage tolerances):

  - *Among the most promising Smart Grid applications in the industry today at the distribution system level and a core element of AmerenUE's deployment strategy*

  - AmerenUE has ~2,300 line capacitors that are automated via one-way radio communication and ~800 tap-changing substation transformers that are automated to reduce system voltage from commands issued by Distribution Control Offices

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Voltage Regulation (cont'd)

Role of Regulation Technology and Equipment

- System voltage reduction has ***proven itself to work*** – AmerenUE documented cases over 15 years show 1.0-1.2% demand reductions after programmed calls for 2.5% voltage reductions

- ***Significant infrastructure investments*** are required to take full advantage of this promising system optimization feature:

  - 1980s legacy system of line capacitor control needs to be replaced, given UE was a very "early adopter" of this automation technology

  - Wireless network infrastructure needed to support two-way communication with intelligent line devices like capacitors

  - New Distribution Management System platform is necessary in order to integrate formerly separate and distinct applications

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Energy Storage Devices

Current and Future Deployment of Devices and Equipment

- Taum Sauk pumped storage plant is the largest energy storage facility in Missouri – 440 MW facility back in service April 21
- AmerenUE technology assessment study in January 2010 found that modern storage technologies are expensive to build ($1700-$5000 per kW), few are field-proven, but are rapidly advancing
- Stronger business cases may emerge due to increases in intermittent renewables, power market volatility, need to defer capital investments
- Small-scale applications could emerge for purposes of peak-shifting or outage response

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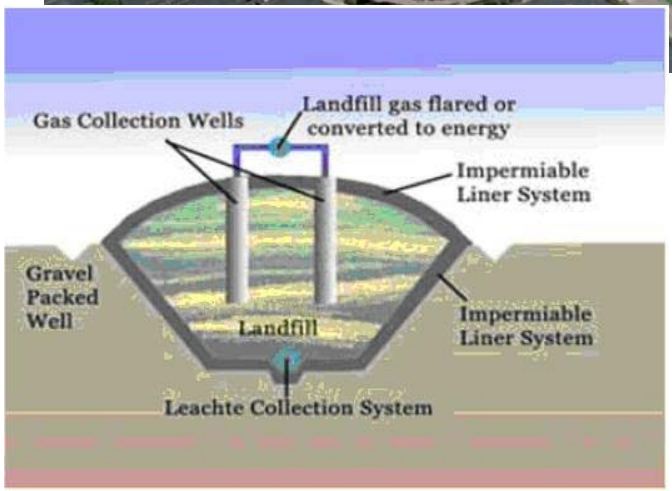
Distributed Generation

Impact of Utility and Customer-Owned Facilities



- 100 kW rooftop solar PV installation on AmerenUE's St. Louis campus will be the largest in MO – construction planned to begin in 2010
- 15 MW "Methane to MW" biomass plant begins generating in 2012 and will serve 10,000 homes
- Rooftop solar (~2 kW) emerging as customer-owned DG of choice – unit cost decreasing, incentives strong
- ~100 "net metering" applications out to date – 15K unit penetration will begin to noticeably affect kWhr sales

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Other Smart Grid Technologies

Releasing T&D Capacity with Existing Easements

- Technologies listed below are key elements of AmerenUE's future deployment strategy and consistent with the degree of reliability, efficiency and optimization that characterizes the Smart Grid

- ***Volt-VAR Optimization*** – minimization of feeder line losses releases capacity directly at the customer utilization level, and more so when accompanied by programmatic voltage reduction – *the only distribution efficiency option EPRI identified as cost-effective enough to warrant consideration in AmerenUE's Integrated Resource Plan*

- ***SCADA Load Monitoring –*** load data on substation transformers, equipment and circuits brought back to a central location for planning and real-time control releases capacity by allowing operation closer to margin – *UE has deployed at 70% of its substations over 30+ years*

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Other Smart Grid Technologies (cont'd)

Releasing T&D Capacity with Existing Easements

- ***On-Line Diagnostic Sensors*** – optimizes utilization of large assets by continually monitoring health of most critical substation equipment – e.g. transformer winding temperature, combustible gas content, HV bushing monitors, etc. – *allows for operating life extensions and "just-in-time" retirement of facilities before failures occur*

- ***Comprehensive Analysis Monitors*** – dynamically rate transmission substation transformers to ensure maximum power interchange capability – *uses inputs from several on-line diagnostic sensors*

- ***Transmission Line Sensors*** – operating temperature monitors, combined with meteorological data (ambient temperature, wind speed) allows for dynamic line rating adjustments during periods of heavy MISO and interchange sales activity

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Other Smart Grid Technologies (cont'd)

Reliability Improvement-based Technologies

- ***Distribution Automation*** – intelligent switching devices automate the distribution grid by detecting fault events and operating automatically to isolate damage points and restore power via alternate routes – *UE has deployed nearly 400 over past 20 years*

- ***Microprocessor-based Relaying –*** single fault detection device replaces multiple electromechanical devices in substations, reducing points of failure and providing self-diagnostic checks that alert personnel of their own operating condition – *UE has deployed at 50% of its substations over past 20 years*

- ***Phasor Measurement Units –*** transmission system sensors allow for better monitoring of grid conditions and help prevent disturbances on the nation's grid from cascading into local or regional power outages

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Other Smart Grid Technologies (cont'd)

Rate Recovery Critical to Widespread Deployment

- Widespread deployment of Smart Grid technologies is very capital intensive between the significant investments necessary in hardware, communications, controls and end-device "intelligence"
- Core Energy Delivery infrastructure needs to be maintained and aging assets require programmatic upgrade and replacement in order to have a system that's "smart-worthy"
- This can only proceed at the ***"speed of value"*** to all stakeholders involved – AmerenUE is obliged to measure this value not only with operational metrics like reliability improvement and efficiencies gained, but by the degree to which we can recover these types of investments in a timely fashion

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