Smart Grid: Implications for Forecasting and Analysis

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Itron’s Forecasting Brown Bag Seminar

March 2, 2010
Please Remember

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- To make the presentation portion of the screen larger, press the expand button on the toolbar. Press it again to return to regular window.

- If you need to give other feedback to the presenter during the meeting, such as, slow down or need to get the presenters attention for some other reason, use the pull down menu in the seating chart and we will address it right away.

- If you have questions, please type your question in the Q&A box in the bottom, right corner. We will try to answer as many questions as we can.
2010 Brown Bag Seminars

- **Smart Grid: Implications for Forecasting and Analysis** - March 2, 2010
- **Sales Forecast Trend Review** – June 22, 2010
- **Technology Choice Model** – September 14, 2010
- **Real Time Forecasting – Issues and Challenges** – December 14, 2010

- All at noon, Pacific Time
- All are recorded and available for review after the session.
Overview

- Discussion of Smart Grid and AMI technologies
- What does not change with AMI
- What does change with AMI
- Examples of roll-up applications with AMI
- How load research and forecasting work today
- Impact on Load Research and Forecasting
The Smart Grid

Defining characteristics:

- Enabling informed participation by Customers;
- Accommodating all generation and storage options;
- Enabling new products, services, and markets;
- Providing the Power Quality for the range of needs;
- Optimizing asset utilization and operating efficiently; and
- Operating resiliently against physical and cyber attacks and natural disasters
# Smart Grid Applications

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Applications</th>
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| IRP       | Efficiency and DR programs (ISO/DistCo/Supplier)  
           | Distributed Generation including Renewable  
           | PHEV (Vehicle to Grid) |
| ATO       | Regional Interaction (ISO/RTO)  
           | Supervisory Command And Control (SCADA)  
           | Substation Automation |
| ADO       | Self Healing Delivery Systems (Peer-To-Peer)  
           | Workforce and Asset Management & Optimization  
           | Distribution Management Systems (DMS) |
| AMI       | Distribution Facility Monitoring & Management  
           | Energy Management: Demand Response  
           | Communications to In-Home Devices  
           | Complex Metering: CPP / PTR / RTP Smart  
           | Meter Data Management/Data Warehouse  
           | Outage & Restoration Reporting  
           | Advanced Metering & Rates: TOU / Demand  
           | Customer Operations: Field Operations  
           | Revenue Cycle Services: Meter-To-Cash |
| AMR       |                                        |

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AMI Enables New Products, Services, and Markets

AMI (Smart Meters) implies two-way communication

Energy Management
  - Demand Response
  - Price Response
  - Direct Load Control

Simple Awareness
  - Going Green

Simple Awareness
  - Renewable

In home display

Smart Thermostat

Plug In Cars

Smart Appliances

Home Control

Smart Plugs

Gas & Water Meters

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Example of AMI Configuration

OpenWay™ Collection Engine

Communication Network

Smart Appliances
In-Home Display
Gas Meter
Thermostat

OpenWay™

ZigBee®

Home Gateway

Wireless Switches and Keypads

Meter Data Management

Distribution Operations

Business Systems

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Things That Do Not Change

- Energy still needs to be generated.
- Environmental concerns remain important.
- It still takes wires and pipes to deliver energy.
- Bills are still calculated and delivered on cycles.
  > This is necessary to smooth workload in the billing process and the call center. This is the same reason that telecom and credit card companies bill on cycles.
  > Cycles are not necessarily "route" based.
- Load profiles continue to be used in rate cases, forecasting, marketing, and special studies.
- Forecasting is still about the future...you can't meter the future.
- Weather normalization and variance analysis remain counter factual exercises that require analysis and modeling.
Things That Do Change with AMI/Smart Grid

- Interval data (hourly or finer) are collected for all customers. Data are available for analysis on a next-day basis.
- Utilities are connected to their customers through smart meters enabling delivery of new programs (pre payment, demand response, net metering, ...)
- Complex rates will be applied more widely and customer bills will be calculated using interval data.
- Profile estimation tasks will be replaced with interval data roll-up calculations, which aggregate data based on financial and physical connectivity data.
- Loss estimation can be addressed directly (net system load minus the sum of loads at customer meters) with some profiling for unmetered loads.
- Low cost capability to analyze hourly loads for market studies, program participant groups, control groups, ...
- Bottom up (customer) data can meet top-town (grid) data to better understand facility loads and revenue protection problems.
AMI Roll Up Calculations

- Validation must be automated.
- Estimated loads can be used for completeness (99% is metered).
- MDMs are transactional systems that can’t necessarily support large roll up calculations.
- The alternative is to configure Warehouse databases and supporting logic to configure and automate roll-up calculations. The result of the calculations (interval data cubes) are then available to applications.
Dynamic Profiling (Load Research with AMI)

- The role of Dynamic Profiling applications is:
  - Perform roll ups of interval data by rate, voltage, and jurisdiction
  - Calculate coincident and non coincident demand statistics
  - Aggregate and scale data to get revenue class profiles
  - Compare profile estimates to system loads to compute losses
  - Store results and make available for distribution

- Calculation timing
  - Each day calculate the profile for the prior day
  - Each month calculate monthly statistics
  - Maybe do an initial calculation and a final calculation

Example – Profile for the General Service Class
Losses -- Improved Clarity from AMI

- AMI data provides bottom up profiles
  > Apply loss factors by voltage level.
  > Aggregate across profiles.
  > Compare to system loads.
    • At system & zone level
    • At substation, feeder level
    • At transformer level (requires grid data).

- Use AMI data to estimate losses
  > Bottom up is measured usage
    • Sum over customers + unmetered
  > Top down is measured
    • Net generation + imports – exports
  > Total losses and UFE are the difference.

- One of the benefits of AMI is improved clarity about energy use patterns by class and by geographic location.
Demand Response Analytics

- Demand response implies the use of dynamic pricing
  - Customer response is enabled through information and in-home technologies.
  - Home energy controllers and smart appliances are key.
  - Studies show significant impacts on non event and additional impacts on event days.

- Operational systems will roll up interval data to support program analysis
  - Calculations can be made each day for the prior day for participants and NP groups.
  - Compare participant group loads with control group baselines.
  - Compare participant group loads on event days with non-event day behavior.
  - Forecast incremental load reduction available through DR events.
Settlement Calculations with AMI

- Settlement calculations in retail markets
  - Financial connectivity to a supplier
  - Currently done with class profiles
  - With AMI, regulators insist that measured customer loads are used in settlements

- Calculations include:
  - Hourly supplier obligations by class, zone
  - Capacity at ISO and zone peaks

- Calculation timing:
  - Next day calculation (A)
  - Final calculation (B)
Financial Calculations with AMI

- Financial closing calculations can be performed directly
  - Current process is indirect and involves estimation
  - With AMI, perform add ups of unbilled energy data by rate and jurisdiction
  - Requires billing date and status information
  - Business rules will vary depending on accounting practices
  - Conversion of unbilled energy into unbilled revenue will remain challenging

- Calculation timing
  - Once per month calculation using data through the end of the prior month
Transformer Load Management with AMI

- Transformer Load Calculations (Bottom up)
  - Virtual AMI (profiled data) is replaced by actual AMI interval data
  - Physical connectivity data is required

- Smart grid data provides top down facility load
  - There will be automated ways to determine connectivity
  - Comparison pinpoints revenue protection problems
Architecture with Data Warehouse

Application Layer

- Dynamic Profiling Module
- Demand Response Analytics
- Demand Response Forecasting
- AMI Revenue Module
- Rate Analysis Module
- Settlements Calculation Module
- Transformer Load Management
- Revenue Protection Analysis

Smart Grid Data Warehouse

Interval Data Cubing

Integration Layer

- Weather Data
- AMI Meter Data
- Customer & Billing Data
- Supplier Relationship Data
- Utility Program Data
- GIS and Connectivity Data
- SCADA & Grid Data
How Load Research Works Today

- **Standard Load Research Processes**
  - Some utilities have active samples. Some do not.
  - Mass market samples are stratified and expanded using ratio or MPU methods. Samples are designed for 90/10.
  - Large customers have interval meters and expansion is a census-based add up.
  - Load research staff are responsible for validation and estimation of interval data for sample customers.
  - Load research staff uses specialized systems to estimate class profiles, usually a monthly or annual process.
  - Class profiles may be calibrated to the total system load net of estimated losses.
  - Class profile estimates are used for rates, forecasting, & marketing. In competitive markets, profiles are used in settlements calculations to turn monthly bills into hourly loads.
How Does Load Research Change with AMI

- Standard load research processes will continue to be used through transition periods. This may be many years in some places.

- Once AMI meters are in place and data collection processes are running smoothly, IT systems will be configured to support interval data roll ups.

- Once roll-up processes are implemented, there will be no need for the load research expansion formulas for estimating class loads. These formulas will still be used in special studies.

- In competitive markets, there is no further need for profile backcasting. All customers have actual (or estimated) interval data for settlements. Commissions will insist that AMI data is used to compute supplier obligations.

- Special studies (e.g., end-use metering, program design, and program evaluation) will continue to require specialized samples.

- Load research departments will continue to manage aggregated profile data, support rate studies and conduct special studies based on statistical samples.
How Financial Forecasting Works Today

- **Standard Financial Forecasting Processes**
  - Budget forecasts are developed once per year, usually in fall. Forecasts may be updated during the year.
    - Sales models are estimated using billing data.
    - Forecasts are for customers, sales, revenues, peaks.
    - Forecasts are for calendar month energy and system peaks.
    - Scenarios for weather, economics,... may be included
  - Monthly analysis of financial results completes the process.
    - Weather normalization of actual monthly sales.
    - Variance analysis of deviations from budget forecast.
    - Estimating calendar month results from cycle results.
    - Estimating unbilled energy.
How Does Forecasting Change with AMI

- The need to estimate (backcast) calendar month energy by class will go away. This will be a direct calculation.
- The need to estimate unbilled energy by class will go away. This will be a direct calculation, providing improved financial clarity.
- Budget forecasting needs will remain the same, but the models will eventually be estimated using calendar month data instead of cycle data.
- Peak forecasting will become more complex because of demand response impacts and the increased role of distributed generation.
- Utilities/Suppliers will be required to provide forecasts of demand response availability to the ISO for day ahead planning.
- Forecasts and tracking of daily energy by class will be enabled.
- Weather normalization processes will continue. This may become a daily process using AMI roll-up data, providing improved clarity and visibility.
- Monthly variance analysis processes will continue. But the calculations will be based on actual calendar month loads from AMI roll-ups.
What This Means for IT Systems

- IT systems will need to be scaled for large quantities of data. 15 minute data for 1 million customers implies about 40 billion intervals per year.

- MDM systems will be one of several contributors to Smart Grid data warehouses that store customer interval data, meter event data, billing data, distribution system data, and transmission system data.

- Some applications will work directly with MDM to provide customer level data and calculations:
  - Calculation of billing determinants by customer for the billing system
  - Customer load data for internal and external presentment
  - Customer level analysis for revenue protection

- Some applications will use interval data cubes that are roll-ups of customer data:
  - Class profiles for rate analysis, forecasting, and marketing
  - Transformer load profiles for distribution system management
  - Calendar month and unbilled energy by class
  - Program level profiles for load management and DR participants

- The role of IT departments in the utility will increase.
Questions?

Press *6 to ask a question or type in bottom, right corner.

2010 WORKSHOP SCHEDULE AND REGISTRATION

- Forecasting 101 – Orlando, FL – April 5-7
- One-Day SAE Modeling Workshop – Las Vegas, NV – April 28
- One-Day Model Building Workshop – Las Vegas, NV – April 28
- Fundamentals of MetrixND – Boston, MA – June 7-8
- Fundamentals of Sales and Demand Forecasting – Orlando, FL – September 20-22
- Forecasting 101 – San Diego, CA – September 27-29
- Australian Energy Forecasting Workshop – Melbourne, Australia – October 19-20
- Fundamentals of Short-Term and Hourly Forecasting – San Diego, CA – October 27-29

OTHER FORECASTING MEETINGS

- 4th Annual European Forecasting User Group Meeting – Hasselt, Belgium – February 25-26
- Annual ISO/RTO Forecasting Summit – Las Vegas, NV – April 26-27
- Long-Term Forecasting/EFG – Las Vegas, NV – April 29-30
- 3rd Annual Australian Forecasting User Group Meeting – Melbourne, Australia – October 18
- 2010 Itron Users’ Conference – Orlando, FL – October 17-19

For more information and registration: [www.itron.com/forecastingworkshops](http://www.itron.com/forecastingworkshops)
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