ITRON SMART GRID FORECASTING

J. Stuart McMenamin, Ph.D.
Itron
Smart Grid Forecasting

» AMI and Smart Grid deployments and technologies
  • Pose new forecasting challenges, but also
  • Enable new forecasting and analytical possibilities

» Focus is on three specific areas:
  • Operational forecasting for the distribution grid
  • Analytics for financial closing
  • Analytics for budget tracking and weather

» The benefits
  • Enable operational efficiencies
  • Achieve financial clarity
1. What is Operational Forecasting

» It is short term (today, tomorrow, the next few days)
» It is at the interval level (hourly, 15 minute, 5 minute)
» It is updated frequently (every hour)
» Example of an hourly operational forecast
What makes Operational Forecasting Work

» There is a strong, stable relationship between weather and load

» Fundamental drivers do not vary from day to day
  • Economy
  • Customer base
  • End-use equipment

» Calendar explains the base

» Weather explains the lift
  • Temperature is key
  • Humidity matters
  • Wind matters
  • Clouds matter
Operational System Forecasting Today

Generation dispatch decisions are made based on SCADA data from generation stations and transmission system tie points.

ISO, TSO, RTO, Utility Ops
-- Day ahead markets
-- Hour ahead markets
Tomorrow -- Moving to the Grid Level

- Requires grid measurement data at the substation or below
- Accounts for emerging technologies and programs enabled by Smart Grid initiatives
Solar Forecasting

Solar Generation
» Variations are caused by changes in cloud cover
» Temperature also matters
» Individual sites are variable
» Aggregations provide predictable patterns.

Aggregation over sites and days

Site 1: Light Clouds
Site 1: Heavy Clouds
Site 1: Variable Clouds
Electric Vehicles (EV) and Plug in Hybrids (PHEV) are a new electric end use. With 30 miles per day driving, an EV is like an electric water heater – it adds about 4 MWh to a residential load.

The main questions are when and where will it be charged.
Studies show that EV loads can change the system load.

It depends on miles driven, saturation, and charging profiles.

Experiments show that the charging profiles depend on rates.

This is especially effective if EV charging is separately metered.
DEMAND RESPONSE FORECASTING

Demand Response Program

- Office Building
- AC Cycling Program
- Thermostat Setback
- Events from 12 to 6 PM
Applications of Smart Grid Forecasting

Grid Load Forecasts = Traditional Loads - Embedded Solar and other Distributed Generation + Electric Vehicle Charging - Demand Response Availability

Distribution Management and Automation Systems (DMS & DA)

End-use Saturation, Energy Efficiency

Output metering, Pricing

EV Metering, Real Time Rates

Demand Response Management System (DRMS)
WHAT ITRON IS DOING

» The Itron Automated Forecasting System:
  • Meets requirements for operational forecasting at the grid level.
  • We are working with our customers to understand emerging needs, possible applications, and benefits.

» Working with utility customers on demand response modeling and forecasting DR availability.

» Working with California ISO on improved algorithms for solar and wind forecasting.

» Working on electric vehicle issues for long-run forecasting purposes
Part 2: Financial Closing

» Billing is by cycle
» Financial reporting is by calendar month
» Each month analysts must estimate:
  • Calendar month sales and revenue
  • Unbilled sales and revenue
» This can be a pain point depending on the methods used
» AMI data allows replacement of estimates with direct measurement
» Partial AMI data can improve estimation process during deployment
The role of billing cycles

- Most utilities use 20 or 21 billing cycles
- Some use 40 bimonthly cycles
- Not always a clean precise process with manual reads or AMR
Why AMI data clarifies the process

» AMI data provides day-by-day usage for each customer
» AMI data is up to date for closing calculations
» AMI is the source of usage data for computing bills

» With AMI data
  • Calendar month energy can be calculated directly
  • Unbilled energy can be calculated directly

» Complicated estimation processes…
  can be replaced…
  by **direct calculations**
Why AMI data clarifies the Process

» Complicated estimation processes can be replaced by direct calculations
Using AMI data during deployment

» There are several estimation methods using aggregated or detailed billing data.

» All methods use profiles to allocate and extend bills
  • Calendar month/billing month ratio \(\frac{(B+C)}{(A+B)}\)
  • Unbilled/calendar month ratio \(\frac{C}{B+C}\)

» Partial AMI data can be used to generate profile data and ratios during deployment

» An example follows at the 30% deployment point.
  • Concern: Is AMI data representative
residential AMI Profiles

» Daily variations in residential AMI data are consistent with data from statistical load research studies

Model of Load Research Data
AMI Data (Daily KWh/Meter)

Corr = .976

July is hotter than normal on most days
August is close to normal

<table>
<thead>
<tr>
<th>August Step-Down</th>
<th>AMI Data</th>
<th>Load Research</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Corr = .976
Comparison of Commercial Profiles

Daily variations in commercial AMI data are consistent with data from statistical load research studies.

Corr = .980
Industrial and System Ratios

- Industrial customers are mostly interval metered already
- Industrial loads increase in August

**August Step-Down**
- System: 12%
- Ind: -1%
Conclusion: Partial AMI data provides a strong basis for computing financial ratios by class in this case.
Understanding weather response

» Looking back at each month, weather effects are quantified to:
  • Analyze variances from budget
  • Track weather adjusted sales against budget

» Weather effects are often modeled with monthly sales

» Use of daily AMI data can strengthen these models

» The result is:
  • Stronger, more robust models
  • More precise estimation of weather effects
  • Improved clarity about the business
Understanding Weather Response

• AMI data is very powerful for understanding weather relationships.
• There are 365 points per year, a strong advantage over monthly data.
• AMI usage on a day can be matched cleanly with weather for that day.
Why this is Important

• Most analysis models are built with monthly data.
• Monthly sales data are from staggered billing cycles.
• Monthly data have less leverage (in X and Y directions).
• Daily data show how weather works.
AMI Data Supports Richer Models

» AMI data shows us when weather starts to matter

» AMI identifies low, medium, and high powered degrees

» AMI data shows seasonal differences in weather response that are not visible with monthly data.

» AMI data identifies weekend effects

» AMI data identifies the strength of holiday effects

» Understanding these effects creates additional clarity
AMI Data Supports New Analyses

» Models of daily AMI data are useful
» Class sales can be adjusted for weather each day
» Class sales can be tracked against budget each day

<table>
<thead>
<tr>
<th>Rate GS, June 2012, $M</th>
<th>MTD</th>
<th>Forecast</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>46.9</td>
<td>25.9</td>
<td>72.9</td>
</tr>
<tr>
<td>Budget</td>
<td>43.1</td>
<td>23.7</td>
<td>66.8</td>
</tr>
<tr>
<td>Wthr Sales</td>
<td>4.8</td>
<td>2.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Variance</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
</tr>
</tbody>
</table>

Adjusted Actual (○) is close to budget (●). This is good.
So What?

» You put it all together and new possibilities emerge
» Improved financial analytics don’t increase revenue
» They won’t decrease cost

» But…when management talks about results
  • There will be no confusion about how the business sits
  • This will relieve a major pain point in many companies
  • Upper management likes this
The Bottom Line

» AMI data provides improved clarity about customer usage patterns and this supports new and stronger financial analytics.
What this means for Forecasting

- Monthly estimations are replaced by direct calculations.

- Budget forecasting needs remain the same.
  - But models will be estimated using daily or calendar month data.

- Weather normalization processes will improve.
  - These processes will be applied at the daily level, providing improved clarity and visibility.
  - Daily tracking will insure that there are no surprises at month end.

- Monthly variance analysis processes will improve.
  - Variance calculations by class will be based on actual calendar month usage instead of estimated calendar month usage.
What Itron is Doing

» Itron Analytics Platform to support analysis of high volume AMI and Grid data
  • Transformer load management
  • Voltage and power quality
  • Revenue protection
  • Dynamic load profiling
  • Financial analytics

» Working with utility forecasting groups on
  • Working to quantify operational grid forecasting benefits
  • Using AMI data during deployment
  • Improving forecasting processes
  • Improving financial closing processes
THANK YOU