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Bulk Power Forecasts Require Accurate Load Data

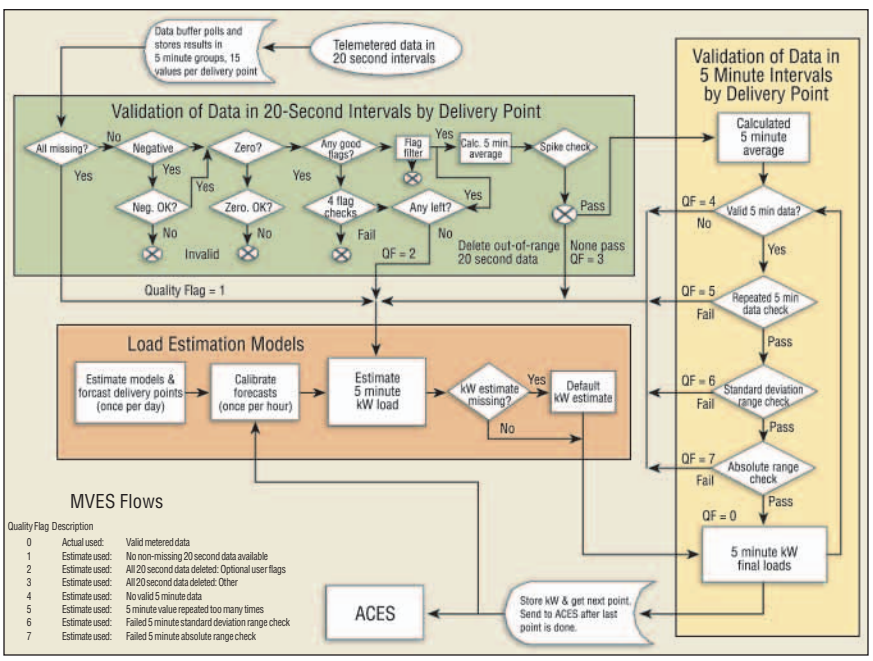
New regulations prompt a cooperative to upgrade its meter estimation and validation system.

By Daryl Jaschen, Old Dominion Electric Cooperative, and John Tweedy, Power System Engineering

The changing regulatory environment in the state of Virginia led Old Dominion Electric Cooperative (ODEC; Glen Allen, Virginia, U.S.) to examine its energy management system (EMS) and the way data are exchanged with its bulk power marketer.

With a state-mandated regulatory deadline approaching, ODEC instituted a broad review of the operational data the utility must provide to its bulk power marketer. This review identified the need for a new system to validate existing load data, and to replace invalid and missing telemetered load data with accurate estimates to provide the bulk power marketer with real-time load data suitable for use in next-day and intra-day forecasting. Implementation and testing of the meter-validation software and the existing load-data acquisition system design changes had to be completed within six months. Work began in August 2002, and the system went live in November with testing continuing through December. The Itron Inc. (Spokane, Washington, U.S.) Meter Validation and Estimation System (MVES) went into production on Jan. 1, 2003.

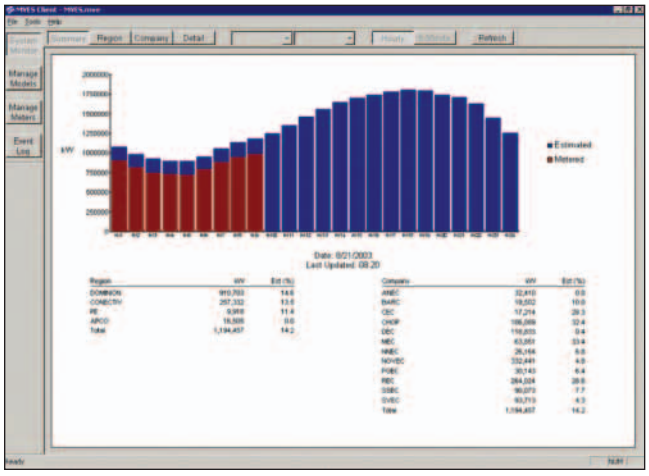
ODEC is the generation and transmission provider for 12 electric distribution cooperatives in Virginia, Maryland and Delaware. More than 200 delivery points serve ODEC's load. Connectiv and Dominion Virginia Power supply the majority of the transmission service, with minor supply by APCO and Potomac Electric. When a cooperative bulk power marketing organization was created on the East Coast, ODEC decided to become an owning partner of the bulk power marketer and turn over all bulk power transaction decisions and scheduling to the staff of its co-owned entity. ODEC sends load information to the marketer in real time via a frame-relay network.



Itron MVES validation and estimation flows.

Requirements, Analysis and Vendor Selection

ODEC uses an EMS provided by Open Systems International (Minneapolis, Minnesota, U.S.). All 12 distribution cooperatives have supervisory control and data acquisition (SCADA) systems. The vendors of these SCADA systems are QEI, Telvent and ACS. At the time the system review began, ODEC was receiving telemetered delivery-point data in near real time for most bulk power delivery points via an ICCP node designed and implemented by LiveData Inc. (Cambridge, Massachusetts, U.S.). ODEC also had accurate hourly billing data available for these



System Monitor: ODEC total load.

System Montior: Member coop total load.

delivery points; however, that data were not available until several weeks after the end of the month.

To begin the systems-analysis process, ODEC contacted Power System Engineering (PSE; Madison, Wisconsin, U.S.) to form a strategic project team and develop the project charter. PSE then facilitated requirements meetings with ODEC and their bulk power marketer. Initially, the focus was on the ODEC EMS applications, but as discussions continued, the central issue became the quality and completeness of the load data at each ODEC-member delivery point. The team concluded that a real-time validation and estimation tool was needed that uses estimates of telemetered loads derived from econometric models of hourly billing data, weather, day type and other factors. Together, the team developed a two-step specification, which was used to solicit guidance and recommendations from vendors and then request their proposals.

The suggestions and guidance received from the vendors led the team to broaden the vendor participation. After evaluating all input, two EMS vendors, plus the load forecasting and software section of Itron (then part of Regional Economic Research) were invited to submit proposals.

Ultimately, Itron proposed the MVES, which was selected as the best solution for ODEC. The main need was for a system that could reliably perform meter verification and estimation function in real time without user intervention and only an occasional need to reconfigure settings.

After much consideration, ODEC decided the new MVES would interface to the existing EMS through the LiveData ICCP node. Itron teamed with LiveData to design the process to monitor and pass the telemetered load data. The solution was the development by LiveData of an ActiveX control that captured delivery-point loads at intervals as short as 30 seconds, to be forwarded in batches to the MVES every 5 minutes for analysis and processing. The transfer of cleaned load data from MVES every 5 minutes for use by the power marketer was managed by the Real-Time Integration (RTI) platform, a product from LiveData.

The Meter Validation and Estimation System

The MVES initially provides the capability to receive, validate and estimate telemetered loads for 218 delivery points with the capability to expand. The 12 member cooperatives receive, update and locally store their telemetered loads databases, which are polled every 20 seconds by ODEC.

The MVES is designed to run automatically, but a user interface is available to allow the MVES analyst to view historic data, view estimated data, review estimation model statistics and historic comparisons, revise modeling approaches, and review and edit validation and estimation parameters. Through database changes, it is also possible to add or delete delivery points and add or revise aggregation groups.

The MVES verifies and filters telemetered loads; converts the filtered loads into 5-minute intervals; identifies out-of-range kilowatt values; replaces missing or out of range kilowatt values with estimated loads; and outputs the corrected delivery-point kilowatt data in 5-minute intervals. The MVES also computes kilowatt values aggregated for each member cooperative and for each supplier.

Statistical models of hourly billing data or telemetered data at each delivery point are used in the validation and estimation process, with the option, for each delivery point, of choosing one of the standard model specifications or developing a custom model using MetrixND. Each night, these hourly models are automatically estimated, assigned to individual delivery points and used for next-day weather forecasts. As the day proceeds, these forecasts are automatically calibrated each hour to agree with the recent telemetered data, providing an updated forecast for the balance of the day.

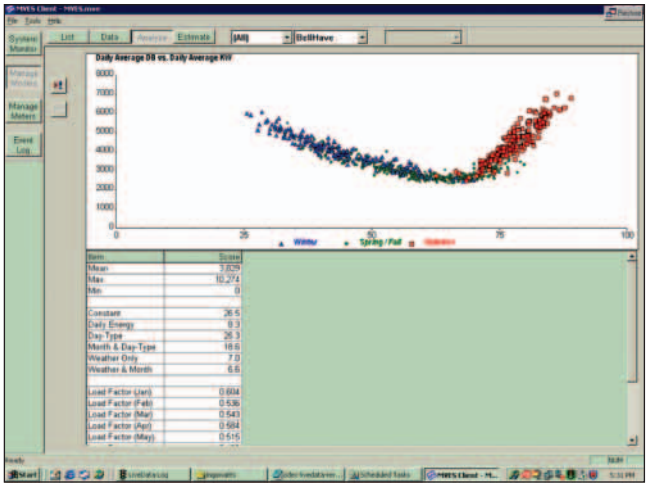
Process Specification

The MVES includes five automated processes run in background. These processes also may be initiated manually through the MVES user interface, which also provides screens that allow the user to monitor performance of the process through charts and data tables, and to adjust meter and model settings and parameters that are used in the validation and estimation process.

Timing and descriptions of key failure and success events are written to an event log, along with an identification of the source, category and severity. Reports of high-severity events can be e-mailed to users.

● *Import and store hourly billing data*. Hourly billing loads are received and stored by ODEC on a monthly basis. A daily MVES task is scheduled to check for new billing data in a specified location. If files are found in this location, they are read and the hourly load data are stored in the MVES SQL Server database. The user has the ability to

Delivery Point Load: 5-minute detail.



Analysis of weather-sensitive load.

mark billing data as bad or to limit the period used for model estimation, as may be necessary if an unusual shift in load has occurred.

● *Verify and store weather data*. Weather data are obtained through a call to a LiveData ActiveX control that returns hourly weather values (dry bulb temperature, wet bulb temperature, cloud cover and wind speed) for the current day and the following day for five stations (Dulles, Dover, Wilmington, Richmond and Norfolk). Data for the individual weather stations is combined in the MVES using fractional weights into data for weather zones.

● *Estimate models, generate forecasts and calculate day type statistics*. This task executes the automated statistical forecast for each billing point that has been assigned a model delivery point. The script that implements this task reads input data required for the specified Itron MetrixND (load forecasting software) model, opens the MetrixND project file, inserts the relevant data into the project file, estimates the model, computes predicted values for the estimation period, computes predicted values for the forecast period, and stores the results into the SQL Server database. The results include hourly forecasts for the current day and following day, default hourly values by season and day type, and standard error values by season and day type. The default hourly values are used in the validation and estimation steps if an hourly forecast is not available for a specific day, as may be the case if a weather forecast has not been received.

● *Import, validate, edit and store telemetered data*. This task is scheduled to run every 5 minutes, at which time validation is done for telemetered loads that have been received from the cooperatives at intervals of between 20 seconds and 5 minutes. The software design philosophy was to make use of as much telemetered data as possible, while having checks in place to identify and reject bad data.

Each of the observations MVES receives from the ActiveX control is accompanied by four quality flags—Validity, CurrentSource, NormalValue and TimeStampQuality—with a zero (the default situation) indicating a normal or valid situation.

The figure on page 44 shows the steps in the validation and estimation process, and the following discussion provides an explanation of that process.

● *Apply scaling factor*. After receiving the Telemetered

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Load data, the MVES can apply a user-specified scaling factor other than one to each observation. The scaling factor is intended to allow adjustments for any differences, such as losses between the telemetered loads and the hourly billing loads.

● *Pre-screen telemetered loads*. Missing observations may occur for various reasons, including the failure or lack of telemetering at the delivery point. If all data are missing, the MVES process jumps directly to the estimation step and the quality flag is set to the value of one.

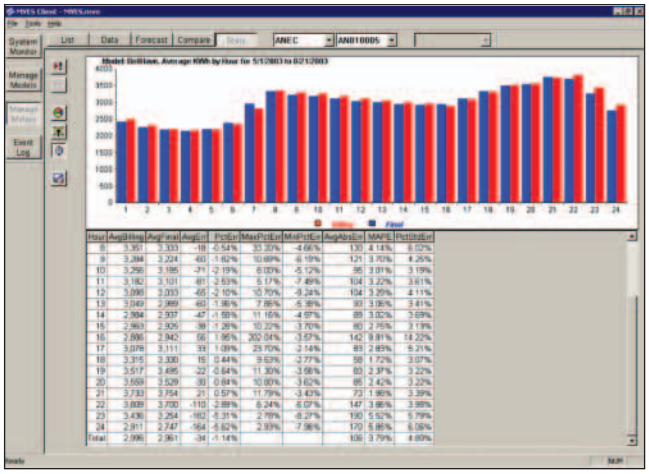
Next are MVES checks for zero or negative values, since these values often, but not always, suggest malfunctioning telemetering. Observations with these values are deleted unless the user has specified the “zeros allowed” or “negatives allowed” options for the delivery point.

● *Validate and estimate 5-minute load data.* After deleting any short-term values screened out by the preliminary spike detection factor, the MVES next re-averages the short-term observations into a 5-minute average.

If the current telemetered load has remained unchanged for a specified number of 5-minute intervals, a condition that often indicates telemetering failure, the MVES jumps to the estimation step and sets the quality flag to four. The user for each delivery point specifies the number of repeated values that triggers this action.

The next, and perhaps most important, 5-minute validation rule is the standard deviation range check. This check deletes observations that are outside of a user-defined number of standard deviations, jumps immediately to the estimation step, sets the quality flag to a value of five, and writes a report to the Event Log.

The final range check is based on simple high- and low-kilowatt ranges entered by the user. This range check typically serves as a “safety net” in the event that the standard deviation range is overly high. Five-minute observations making it through the final range check are added “as-is” to



Manage Statistical Models: Data view.

the stored kilowatt results for use by ODEC bulk power marketer, and their internal MVES quality flags are set to zero, indicating valid telemetered data.

The MVES also has an emergency backup in the event that no current day forecast exists. This could happen, for example, if no weather data were available or a hardware failure occurred at the normal time of daily forecast. The first emergency backup is the substitution of calculated averages by hour, day type and season.

The Itron MVES has been an overwhelming success. The software system was actually designed, developed, installed and tested well within the required six months, and the software performed as specified. In addition, Itron included a robust set of analytical tools that enabled the data evaluation process.

Most impressive of all was the quality of the results. The MVES identified many metering and data collection problems that could not be identified previous to the implementation of MVES. In fact, approximately 30 of the bulk power-delivery points are not telemetered, and the MVES is relied upon as the primary source of real-time information for these delivery points. Another significant feature is that ODEC has found that its residential loads strictly conform to the weather patterns, which results in highly accurate estimations from the MVES.

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