Using an Engineering Model to Determine a Customer's Baseline Load

Viridity Energy, Inc.

A customer baseline serves as an estimate of how much electricity a customer would consume during a given period, absent any controlling actions taken by a customer in response to price. The standard approach bases this estimate upon the customer's consumption data during some number of days prior to the date being estimated. For example, the NYISO creates a baseline for Special Case Resources based on Average Peak Monthly Demand ("APMD"). The APMD is the average of the one-hour peak loads during the noon to 8 P.M. time period during the four (4) middle months in the previous like Capability Period. Similarly, the NYISO's Day-Ahead Demand Response Program and its Emergency Demand Response Program also provide for a Customer Baseline Load calculated based on the customer's electricity usage in specified prior hours.

The problem with the standard approach is that it is not necessarily representative of the load that would actually have been experienced on a given day, absent demand response. The assumption that a day's load would be the same as the load on a handful of recent past days is not necessarily correct and could be proven wrong based upon such items as a change in the scheduled use of the customer facilities, on differences in weather patterns and conditions, and on differences in the starting state of the site.

Viridity proposes to calculate a baseline by objectively, deterministically, and scientifically calculating the expected load, thus avoiding the problems associated with the standard approach. We believe that the proposed method will work particularly well for customers who perform frequent load management in response to wholesale prices. Customers who actively participate in demand response programs will take actions to reduce their facilities' electric demand, such as adjusting building temperature settings, temporarily activating interruptible loads, and performing other techniques, all in response to high wholesale market prices. These customers will alter their energy consumption patterns consistent with market price signals and thus will benefit grid reliability. However, their frequent load management also reduces the number of recent, similar "no-action" days that can be used to develop a baseline.

Viridity uses a predictive approach, instead of a historic one, to calculate how much electricity a customer would have consumed had it taken no action to reduce demand in response to price. Instead of using historical loads as indicators of present consumption levels, Viridity proposes to model all assets related to the generation and consumption of electricity. A series of mathematical models determines how much electricity the customer would have consumed absent any response to price. This predictive approach will work equally well in the Special Case Resources program, the Emergency Demand Response Program, and the Day-Ahead Demand Response Program.

The proposed baseline will be open and transparent. Viridity proposes to share the inputs and algorithms at any time with interested parties such as the LSE, the ISO or others who have a legitimate interest.

The calculation of consumption for each day will reflect all of the known relevant variables, such as building materials, thermal properties of the building, building occupancy, ambient and desired temperature, solar heat gain, internal heat gain from sources such as lighting and business equipment, HVAC system performance parameters, planned operations for the day, etc. Interruptible loads and their pre-defined responses to a price signal will be identified separately from the baseline calculation.

The proposed method has several advantages. It is objective; it is deterministic; and it is completely transparent. The inputs and the algorithms are documented and can be reviewed. The business-as-usual load calculation methodology is defined in advance and cannot be gamed by behavior designed to influence the baseline calculation. Moreover, the model develops a baseline for the actual day for which a settlement is proposed; thus, it fairly represents business-as-usual load, unlike a historic average which may not do so.

The proposal also incents investment in DR activity. As described above, the baseline is calculated each day based on 'business as usual' load, absent any response to price. Thus, demand response activity on a given day will not affect the baseline, while changes in building occupancy or manufacturing schedule will have the necessary effect on baseline.

Finally, Viridity's software solution will retain a record of all actual demand response actions taken by an end-user. Thus, concerns about whether a customer is truly taking action to reduce demand in response to price or NYISO direction are addressed in a demonstrable, objective, and deterministic fashion. The actions will be clearly visible in history and can be easily compared to metered load readings. Expected changes in load resulting from specific actions can be compared to actual changes in metered load.

Technical Description of Engineering Model of Customer Baseline Load (CBL)

The Viridity baseline methodology replaces historical data as the means of determining the electrical load under standard operating conditions, or business-as-usual conditions, with an engineering model of electrical load. This model can be used to determine the electrical load under any combination of internal and external factors affecting load.

Under this approach, the overall client facility will be modeled as a group of sub-models of all energy consuming elements comprising the facility. Variable load as well as interruptible load equipment must be modeled specifically. Energy consumption of machinery will be measured and modeled individually, as will items constituting a fixed load.

Building thermodynamics is one of the most important processes that must be modeled in order to accurately determine electrical loads. The model uses a set of thermodynamic equations to determine:

- The thermal mass of each building;
- Energy inflow due to conduction, the difference between building internal temperature and ambient temperature;
- Energy inflow due to solar radiation through fenestration;
- The amount of energy emitted per hour from a person present in the building, including the energy emitted by computers and other office equipment; and
- The energy exchange resulting from HVAC systems and chillers or electric heaters.

The model then relates these thermodynamic equations to electrical load, based on the power consumption of HVAC and chillers, their efficiency, and the power consumption and efficiency of ventilation systems.

There is a wide variety of other variable/interruptible load equipment types that will be accurately modeled. It is easily within the state of engineering science today to accurately model industrial and other types of electrical-energy-consuming equipment, as evidenced by the popularity of software packages that contain such models. Viridity has developed appropriate, sound mathematical models for these items based upon the laws of physics describing their operation. The granularity of these models will be that necessary to accurately calculate the actual load of a client's facility as measured against the metered load. Sub-metering is used as necessary to validate mathematical models of variable/interruptible loads.

For large scale facilities consisting of multiple buildings or elements, the total baseline is simply the sum of the baselines for the individually-modeled aggregated elements.

Viridity's process for developing the model of the client's facility is iterative. A generic, or representative, model of the client's facility is first developed. Experiments are then performed on the client's buildings to determine their thermal parameters. Sub-metering is used as necessary to accurately determine fixed and variable loads as previously discussed. The experimental results and load data are incorporated to modify and tune the generic model. Once the model is created, it can be validated.

Model Validation

To validate the model, Viridity will conduct simulations of the client's facility. The simulations use historic data from prior days for which actual metered data and actual historical conditions are available. The model calculates the hourly electrical load for those days. Model output is then compared to actual historical metered loads. Further experimentation, data collection, and model refinement is performed until the model accurately reproduces metered data.

The model should be tested and validated using a prescribed statistical methodology. We propose the following statistical tests, but are open to any set of tests deemed appropriate by NYISO:

1. Run simulations that include days from all seasons, different days of the week, and high/low price LMP days.
2. Key evaluation criteria include:
    a. The Median Absolute Value of Percent Errors represents the accuracy of the baseline calculation method.
    b. The Median of Percent Errors represents the bias of the baseline calculation method. A negative value indicates that the baseline calculation method under-predicted load for test period.
    c. Standard Deviation of Percent Errors represents variability in the performance of the baseline calculation method.
3. Apply similar tests for the standard historic baseline calculation, and require that any alternative baseline calculation be more accurate than the historic approach.

When proven statistically, the model and validation data should be reviewed by NYISO, the associated LSE and other involved and interested parties. A model that meets the objective accuracy criteria (that is, the model produces results that are more accurate than the standard baseline calculation) should be approved for implementation and placed on file at the ISO. The model and its use should be audited periodically by the ISO to ensure that it continues to meet the NYISO accuracy standards. Viridity requests that the standards be quantified and defined in the appropriate Manuals.