

## POWER DEMAND

### SHORT AND MEDIUM TERM ELECTRICITY DEMAND FORECASTING

The difficulties of forecasting demand for electric energy are well known to retailers in the energy market. The financial costs for imbalances between forecasted and actual demand can be significant as different levels of penalties are imposed. Minimizing the penalties can only be achieved with reliable forecasting methods and tools. Accurate demand forecasting is also valuable when analyzing the market and calculating expected market prices, especially when analyzing large geographic areas. Powel Demand is an advanced forecasting solution for companies involved in the electricity power market - either as a retailer, trader or even as a system operator. It provides accurate demand forecasts based on historical information and weather forecasts.

#### EXPENSIVE IMBALANCES

Electricity is a commodity that is produced and consumed simultaneously, so there is always a perfect balance between supply and demand in the power system. Retailers of electric energy must be able to predict the future demand in their own supply areas as a basis for their own bids, contracts and commitments. The cost of imbalance related to power market contracts can be significant depending on the imbalance in the total power system. Imbalances between contracts and physical delivery are normally caused by unpredicted weather conditions, special events (like accidental outages of large consumption categories), stochastic variations in load, or simply inaccurate forecasts. The imbalance is charged at a cost which is dependent of the imbalance in the rest of the power system. In general the cost of imbalance is equal to either the spot market price or the regulating power price which can be quite costly during certain periods. The main benefit of accurate demand forecasts is reduced imbalance cost and reduced costs of buying or selling power in the Elbas market.

#### IMPROVED FORECASTING OF DEMAND

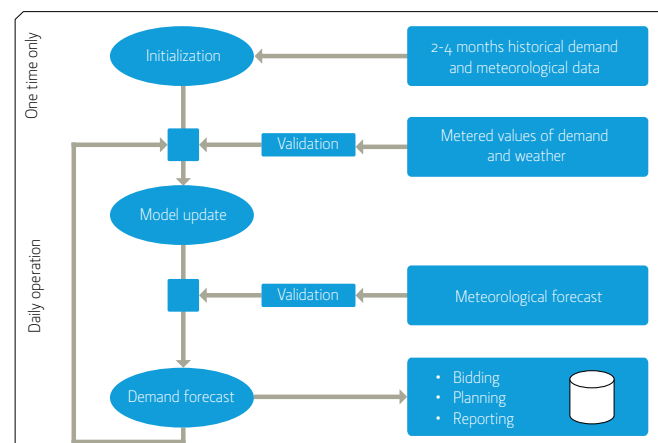
Powel Demand is a tool for forecasting electricity demand and works by combining historical information about consumption correlated to variations in weather parameters (temperature, wind, sun radiation) and patterns in consumer behavior correlated to calendar and time of the day (variations over day/night, week, seasons, holidays). The period of forecasting is normally as long as the weather forecast is significantly reliable, typically up to 10 days ahead. Forecast of electricity demand is calculated and stored in time series with resolution normally ranging from 15 minutes to one hour intervals. The demand forecast is typically recalculated every day when new weather forecast information becomes available.

Powel Demand is a “self-learning” model based on Kalman filter technology. The model and its use of parameters are intuitive and easily explained, making calibration and tuning a simple task. Time dependent load variation parameters (season, weekday, time of day, and special holidays) are defined, along with a weather model covering the variables of temperature, wind and sun radiation.

#### USE OF POWER DEMAND

The operation of Powel Demand is based on a few logical steps. First, the model must be initialized for any new forecasting area (could be a country, a region or a specific group of customers), and historical data must be imported for all the variables in the model.

Typically the model needs at least four months of data to produce a good calibration. When the forecasted values for climate parameters are imported, a demand forecast will be calculated.



Once the day has passed, and the actual demand and weather parameters for previous day have become historical facts, the actual (metered) values should be entered into Powel Demand. The collection of required input data may be an automated batch process, or in the form of manual imports. The actual electricity consumption within the forecasting area for the previous day is measured and stored as time series in the database. This time series is used as input to the daily update of the Powel Demand model. The correlation between metered weather data and metered electricity consumption is analyzed during these daily updates. The results from these analyses will continuously be added to the statistics to improve the accuracy of coming forecasts.

All the demand forecasts are stored as time series in the Powel database. For exchange with other systems, the time series may be exported in a number of commonly used formats like .csv or .xls.

### THE BENEFITS OF POWEL DEMAND

Powel Demand is a valuable solution for companies operating in the electricity market. Besides stating the obvious, that the users get very accurate demand forecasts, there are a number of benefits for users of Powel Demand. The modeling itself is extremely flexible, where users determine the time period for the forecast, the target consumer group or area to be covered, and the weighting of all the input parameters. The results from the model improve over time (self-learning by use), and the results can automatically be exported to other systems in a variety of formats.

Good demand forecasts result in better accuracy in meeting contract commitments, which is a key to improved economic performance in any electricity market. Powel Demand is a robust system with a long track record, being successfully used in regions with different climatic conditions.

Powel Demand utilizes the Powel Time Series Manager which stores and processes time series and is the core system for a number of Powel applications. Application of metered data and time series for different electricity market tasks is easily performed, due to this integration of system solutions. The following integrated products add value and benefits to the total solution:

- Powel Smart Generation – planning and optimizing of hydropower generation
- Powel Trade Organizer – Trade organizer for balance calculations and management of contracts and trade information
- Powel MDMS – Metered Data Management System
- Powel Bid – Electricity market bidding

### POWEL SMART GENERATION

Powel Demand is part of the Powel Smart Generation portfolio, which consists of integrated computation engines for forecasting, simulation and optimization.

The Powel Smart Generation portfolio also utilizes Powel Time Series Manager, which will automatically collect, validate, correct, scale, sum and store input and output data in the database to be used in the planning process.

