

## *Model parameter estimation, calibration and forward curve building for energy and power markets*

### **Product Description**

Energy derivatives valuation requires robust and accurate derivative pricing models. However, derivative pricing models are only as good as the input data; and the most difficult data to estimate is "model data" such as volatilities, mean reversion rates, forward price curves, and so forth. Collectively, parameter estimation and model calibration are considered a crucial step in the overall modeling workflow. In fact, many energy professionals would argue that model calibration deserves the same degree of attention as the derivative model itself.

@ENERGY/Forward Curve addresses the key data challenges faced by industry professionals working in today's illiquid energy markets. @ENERGY/Forward Curve is designed to fill in the key gaps in a company's market and model data. By using @ENERGY/Forward Curve, energy companies are able to derive high quality model data – and high quality model data translates into high quality derivative valuation and risk estimates

**What makes @ENERGY/Forward Curve unique?** @ENERGY/Forward Curve can derive model parameter estimates by incorporating multiple types of historical and current market data. Further, all outputs are 100% compatible with other @ENERGY modules thus allowing for immediate integration. @ENERGY/Forward Curve is one of the modules of the @ENERGY suite.

### **Product Benefits**

- Build, extend, and shape forward price curves in markets where forward prices are illiquid or non-existent.
- Shape a power or gas forward price and volatility curve down to a monthly, daily, or sub-daily granularity, and calibrate jump diffusion parameters and mean reversion rates.
- Extract and analyze seasonal characteristics from historical spot power and gas prices.
- Derive parameter estimates for a comprehensive set of models including: Lognormal Mean Reversion, Lognormal Mean Reversion Jump Diffusion, Regime-switching Jump-Diffusion Model, and FEA's Multi-factor seasonal PCA model.
- Blend the historical volatility structure into implied volatility for more accurate depiction of the seasonal nature of gas futures volatility.

### **Key Features**

- Extensive Model Coverage — @ENERGY/Forward Curve is designed to calibrate FEA's single and multi-factor models which incorporate seasonality, mean-reversion and jumps – salient features of energy prices including gas and power.
- Multi-staged Calibration — @ENERGY/Forward Curve uses historical spot and forward prices as the basis for calibration. Additionally, calibrations are carried out to further incorporate market conditions when they are specified in the forms of current trade prices and/or implied volatilities.
- Detailed Statistical Analysis — @ENERGY/Forward Curve performs detailed statistical analysis on the input data, generating profiles and goodness-of-fit measures.
- PCA and Simulations — @ENERGY/Forward Curve performs seasonal Principal Component Analysis using historical forward prices, and provides simulation tools to visualize results.
- Comprehensive Data Filtering — @ENERGY/Forward Curve enables the user to filter data by specifying relevant seasonal and observation windows.
- Power Peak Specification — @ENERGY/Forward Curve allows the user to specify custom peak hours for separate calibrations of on-peak and off-peak prices.

## Key Features (continued)

**Flexible Inputs.** With @ENERGY/Forward Curve the user can:

- Specify different time granularities for calibration.
- Specify different time steps for outputting forward/volatility curves.
- Specify different power peak hours depending on the days of the week and holidays.
- Specify a subset of model parameters while calibrating the rest.

**Comprehensive Results.** With a single function call the user can obtain:

- A forward price and volatility curve for any specified time period.
- Price and volatility profiles for hour-of-the-day, day-of-the-week and different months.
- Complete model parameter values: mean-reversion, drift, jump, etc.
- Detailed distribution measures: mean, variance, skewness, kurtosis, etc.
- Detailed PCA results: factor scores and factor loadings.
- Simulated price trajectories and histograms.

## Software Architecture

@ENERGY is a Microsoft Excel® Add-In that is written completely in C/C++ providing for extremely fast calculations. It includes Excel Add-In functions (XLL files), customizable Excel templates, and documentation. When installed, @ENERGY XLLs add functions to Excel that are used like the built-in worksheet functions, allowing users to customize the included templates or create new ones. @ENERGY is also available as the ErgLib C library for Unix and Windows programmers who want to incorporate @ENERGY functions into custom and third-party C, C++, Visual Basic, and SQL database applications.