

Weather Derivatives Play Vital Role in Hedging Risk

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Traders Must Rely on Meteorologists for Trading Strategies Input

Weather conditions and, more specifically, temperature, are the largest variables affecting an energy company's total revenue and bottom-line profits. An improved understanding of weather and local climate conditions, in addition to accurate weather forecasts, is essential for improving trading/hedging profits.

Weather risk is potential range of variability in revenue and profits resulting from deviations in the weather patterns, typically within a predefined time frame such as summer cooling or winter heating seasons. Most power companies manage this risk through futures markets, since they all have a natural exposure to the vagaries of weather.

The relationship between warmer winter temperatures and lower demand for heating fuels is apparent (see figure). Conversely, cooler than normal summer temperatures reduce electric power demand for both residential and commercial space cooling. Lower energy throughput translates into higher unit costs of power production reducing power company profits.

Hydro electric power producers are affected by stream flow. Lower than normal snowfall or rain in catchments reduces power production, which also results in net increase in unit costs of power production and lower profits.

Tools for Traders

Since weather plays such a vital role in energy price movement and profits, traders need to rely on the expertise of meteorologists to provide both short-term and long-term forecasts as an input into their trading strategies. Over the past few years, faster computers have opened the door for more forecast models to be developed by the U.S. National Weather Service (NWS) and for more frequent updates of these models. Knowing the update times and biases in each of these models can provide a trading edge over less informed traders (see table).

The NWS provides general update times, and those updates that occur during market trading can have a significant impact on short-term price movement when forecasts are adjusted warmer or colder. At the other end of the time scale, relationships between phenomena such as El Niño, volcanic aerosols, and sunspots are used to make forecasts one to three seasons ahead, with forecasts based on an analog cycle approach.

Short-term Forecasts

The NWS runs several short-term models. Key update times are around 11 a.m. and 11 p.m. EST and provide updated forecast information for the next 48 to 72 hours. These output from the daytime model run are used to adjust that afternoon's maximum temperature forecasts as well as the minimum and maximum temperature forecasts for the next two days. Where precipitation is critical, adjustments in amounts and coverage are also made for the

period. Model guidance indicating an adjustment of only two degrees or more in the today's maximum or tomorrow's minimum temperature for a region can have a big impact on energy demand and consequences for futures prices. Short-range forecasts of temperature have increased in accuracy over the past few years with the improvements in models and increased number of models to provide an ensemble approach to making forecasts. Short-term models are also used to update hourly forecasts of weather conditions for the next 48 to 72 hours to help utilities adjust their load forecasts.

Medium Range Forecasts

Once per day forecast models provide guidance for the next 10-day period. Both European and U.S. weather services run models and make them available before 6 a.m. EST each day. Most forecasters rely on these models as guidance for making 3- to 10-day forecasts. Temperature forecasts for this period show much less skill than the short-term models already discussed, but they do provide enough skill to gauge the intensity and duration of cold or hot temperature outbreaks. Forecast model guidance is provided in 24-hour intervals, which allows for making daily temperature and rainfall forecasts for each day in the 10-day forecast period. Temperature and rainfall forecasts based on these models for this 3- to 10-day period are released by private forecasters each morning before futures markets open day trading. This information helps utilities and traders to determine the

demand for energy locally and nationally over this period and can have an important influence on futures price movement.

Despite the fact that these models are run 7 days per week, the NWS only updates its 6- to 10-day forecasts on Monday, Wednesday, and Friday afternoons at 3 p.m. EST. Since the energy markets are open at this time, the release of the official forecasts can also influence the futures markets. The NWS 3- to 5-day updates are also released at 3 p.m. EST, but these forecasts are updated 7 days a week.

The U.S. weather service has also recently been providing model forecasts of upper atmospheric conditions extending out to 15 days. The weather service makes slight variations in initial data conditions and runs an ensemble of models to determine consistency in the response of the equations for estimating future conditions.

These models are still considered experimental; however, the NWS expects to replace its Monday, Wednesday, and Friday 6- to 10-day forecasts with 8- to 14-day outlooks in late 1998 or 1999. The current 3- to 5-day outlooks will become 3- to 7-day outlooks.

Long Range Outlooks

The short and medium range models extending out to 15 days can be useful for extrapolating out as guidance for 30-day outlooks, but beyond this period a different approach is used for making seasonal outlooks. The NWS updates its long-lead forecasts in the middle of each month, extending out for the next year. Private forecasts of

long range outlooks are typically done on a proprietary basis and are not widely released to futures market traders.

The approach used for making long range outlooks varies between the NWS and even among the private sector. All forecasters tend to agree on long range forecasts for seasons that are influenced by El Niño or La Nina because of the overriding strong atmospheric correlations observed with these events. The very warm winter of 1997/98 over the northern United States was forecast with high accuracy due to the development of an El Niño in the late spring and summer of 1998. The expected development of La Nina in the second half of 1998 would have the opposite impact on northern U.S. temperatures in the winter of 1998/99.

When neither a La Nina or El Niño is a major influence on forcing a consistent atmospheric pattern, long range forecasts are based on matching cycles to correlate recent past weather observations and extrapolate from an analog or set of analog years the weather that subsequently occurred in these same cycles. The cycles that are used to match analog years will vary among forecasters in the NWS and private sector. Cycles typically looked at include solar activity (both short-term bursts of energy and the 11/22 sunspot cycle), and the quasi-biennial oscillation of stratospheric winds that are thought to modulate the height of the troposphere (lower atmosphere) and may therefore

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affect world pressure patterns. This cycle completes itself about every 18 months. The Madden Julian Oscillation (MJO) is a pressure pattern of tropical nature that completes its cycle every 30 to 60 days. The MJO varies in intensity and can give an El Niño or La Nina-like global signal of world pressure patterns over a one-month period of time, whereas the El Niño/La Nina patterns typically last for about 12 months. The North Atlantic Oscillation (NAO) also has a typical cycle period of 30 to 60 days and is typically associated with a Greenland blocking (or troughing) pattern that (in mostly non-summer months) helps to alter the path of polar air masses either into or away from the lower 48 states. Finally, volcanic aerosols provide a wild card in long range forecasts, since there is no regular cycle of eruptions, and eruptions of high vs. low latitude (of great enough intensity to put significant aerosols into the stratosphere) can have opposite effects on temperature forecasts for

as much as a year after the eruption.

With all of the science involved in compositing a long range forecast, the art of selecting the correct cyclical variables in the analog analysis would largely determine the accuracy of these seasonal outlooks.

Although most long lead forecasts (in non El Niño/La Nina) years show little skill, the importance of an educated guess at the long range outlook can be of value to the energy sector in determining potential strategies for traders or measures that a utility company might utilize to insure steady revenues. These strategies today include using futures markets as a hedge, as well as recently introduced weather derivatives.

Weather Derivatives as a Hedging Strategy

Weather derivatives were designed to help energy companies hedge volumetric risk, while commodity prices affect the margin at which a single energy unit is transacted. The problem with using futures markets solely as a hedge for price



All power companies are exposed to the vagaries of weather. Union Electric Co.'s Huster bulk substation in St. Charles County, Mo., experienced its menacing side when it was flooded four years ago. Photo courtesy of Union Electric Co.

risk is that commodity prices may not correlate well to local conditions. For example, a cold winter in the Midwest or Northeast may send natural gas prices in the New York Mercantile Exchange soaring, while mild winter conditions in Phoenix make local demand lower. The lower throughput of energy in Phoenix makes the per unit cost of servicing customers higher. Using futures markets to offset this soft demand (resulting in lower revenues to the energy provider) in Phoenix may be too risky in this situation. Weather derivatives provide a better means of hedging volume risk. There are problems associated with writing a weather derivative contract (besides finding customers to take the other side of the risk). These problems are associated with the utilization of forecast weather data in formulating the contract. If derivative contracts are written for a period spanning several years, the importance of

Weather Forecast Models

Model	Coverage	Valid Period	Time Available	Biases/comments
Nested grid	North America	48 hours	10-11 a.m., p.m. CDT	Most commonly used model. Too slow with arctic air in plains.
Eta	North America	48 hours	10-11 a.m., p.m. CDT	Better handle on arctic air infusion; slow with arctic air in plains.
Aviation	Global	72 hours	2-3 a.m. CDT	Underestimates storm strengths and cold air movement.
Medium range	Global	72-360 hours	4-5 a.m. CDT	Too fast with pattern changes; forecasts quick to break ridges.
European	Global	144 hours	8-10 p.m. CDT	Too strong with Canadian highs; Slow with pattern changes.