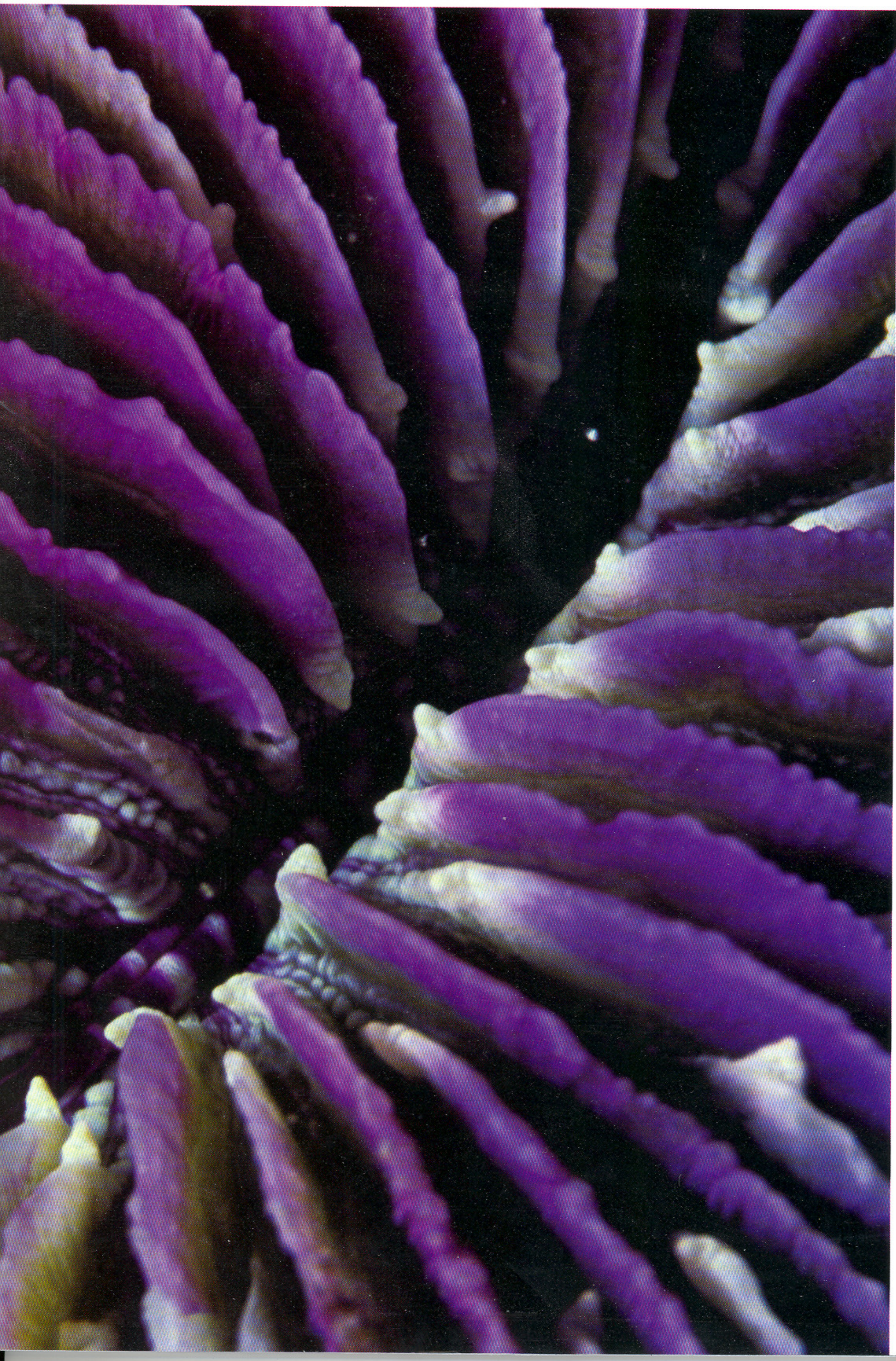
MAY 2004

Environmental Finance

CLIMATE CHANGE; EMISSIONS; WEATHER; INVESTMENT; LENDING; INSURANCE



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Turning weather forecasts into business forecasts

Mary Altalo and **Monica Hale** report on recent studies that show how enhanced weather forecasts and climate data can be used for competitive advantage in the power sector

Power generation, transmission and distribution companies are becoming increasingly aware of the overall risks to capital posed by weather conditions and, over the longer term, climate change. Weather is often cited as the 'tipping point' causing unreliability in the system, decreasing the efficient supply of power and resulting in extra costs.

Unpredicted sea breezes, back-door fronts, afternoon thunderstorms and other identifiable weather conditions tend to result in over-estimated forecast demand. However, even higher costs arise from forecasts that underestimate summer temperature extremes, which can result in reliability problems. These costs can run into millions of dollars per event.

While the use of weather derivatives has gained considerable momentum in the industry over the past five years, there is an alternative, effective mitigation strategy available, namely to make better use of environmental forecast information to manage risk to supplement and/or replace the use of weather derivatives. This essentially represents a change in paradigm from using environmental information for regulatory compliance to using it for competitive advantage. Hedging risk with information is the goal.

How environmental data translates to risk, how risk translates to the bottom line and how to manage this risk are the key steps in analysing management options. Financial risks to power companies arise within specific time frames – from hours to decades. For example, short-term cost-effectiveness requires accurate modelling and weather forecasting on a one- to two-day basis as this influences power pricing, marketing, scheduling, generation and bidding power into the system. Similarly, the two- to four-day forecast is essential to schedule transactions accurately, commit 'must run' generation and 'call' tariff events (reducing power to certain consumers at times of peak demand).

Energy companies use weather/climate information on various time scales (see figure). They need to know what weather information is available, how accurate it is, how to access it, how to use it to inform decision-making in their operations and how to employ it for strategic planning. They also need to know which decision aids and management tools are most appropriate and effective at using the information. The 'value' of environmental information, particularly temperature and air quality forecast data, can be demonstrated by its impact on pricing, scheduling, risk management and, ultimately, the bottom line.

The conceptual model

Over the past five years, the SAIC Weather, Water and Climate Services group has conducted a number of studies into the use of enhanced weather and climate forecast information in the energy sector and its economic potential, with a view to facilitating more effective management and mitigation of risk.

The process included baselining and benchmarking the uptake of weather/climate information in the industry, performing gap analysis and economic valuation of associated costs, creating scenarios for improvement and performing a real options analysis to attain the desired outcome. Essentially, the challenge is to turn a weather forecast into a business forecast to give optimal outcomes and actions.

Real time and site-specific information

☐ *Dynamic line loading* Real-time on-site weather data can be used in energy companies' site-specific adaptive control strategies. Many power transmission reliability problems occur at high temperatures at times of peak power demand. The amount of power that can be transmitted through power lines is directly related to the temperature-based rating of the line, so real-time environmental information is used to maintain reliability by transmission and distribution companies. In several instances, regional transmission and distribution companies are switching from 'static line loading' to 'dynamic line loading' in which power is more efficiently dispatched in a non-uniform way over the grid, depending upon the capacity of the lines to 'accept' the power. This capacity is influenced by the temperature field (in which wind has a major impact).

The use of real-time temperature information and line capacity information for power system optimisation is estimated to have saved PECO in Pennsylvania (now Exelon) $1 million in summer 1995 because the company could increase the load along key transmission lines by monitoring the wind and temperature instead of buying excess power from Delaware.

☐ *Emissions control* In addition, real-time temperature, wind speed, wind direction, dew point precipitation and site-specific pressure information can be instrumental in ensuring regulatory emissions compliance and safety issues.

A major issue facing power utilities over the next few years is how to manage environmental and emissions portfolios proactively. Over the next decade, the jurisdiction for emissions compliance (ie, for nitrogen oxides) will be handed over from the federal government to the states in a phased process. As each state has its own guidelines on how emissions are to be handled, air quality forecast information is likely to play an ever-increasing role in the future management of generation on a state and regional basis.

There is also a growing trend towards manage portfolios of emissions allowances proactively. The challenge is to develop a methodology to look at all of the variables, including fuel switching opportunities, tolling deals etc, which might inform the decision on when to buy or sell allowances.

Short-term forecasts

☐ *Generation commitment* The impacts of imprecise short-term forecasting can be severe. For example, in areas of major wind events, afternoon thunderstorms and unpredicted storms cause power drops and surges to occur. More accurate capturing of weather events could therefore lead to a reduction in unscheduled power utilisation.

A study being undertaken in the Western US has analysed the value of both short-term and long-term weather and load forecasting in the planning and operation of an independent system operator. Short-term forecasts are used for estimating peak loads, for scheduling generation, and transmission. Long-term forecasts tend to be used more for transmission capacity and infrastructure upgrade planning.

The case study has shown that the 'delta breeze' that occurs frequently between May and October in the San Francisco Bay region is a primary cause of unexpected regional cooling and thus power demand drops. Such load imbalances can often lead to an over-commitment of generation costing anywhere from $50,000 to $1 million per event. Important issues here are the integrity of the weather data, the representativeness of weather stations, and the validity and reliability of the load forecast model. A major research effort is under way to improve the forecast accuracy, which could lead to savings of billions of dollars.

☐ *Tariff scheduling* Short-term forecasts of the order of four days are critical for tariff scheduling (the reduction in power to volume customers to curtail load during peak events in return for reduced rates). The goal of a tariff is to schedule power demand up to a week in advance of when temperatures are at peak; therefore, there is a need to incorporate a reliable mid-term weather forecast, particularly when there will be extended heat, to maximise the chances of a tariff call meeting its objectives.

☐ *Commitment of expensive must-run generation* In another study for the northeast US, it was found that, while overall weather forecast error averages 1–2°F a year, the major costs to the power industry are associated with significant errors that occur with unforecast events, often on an hourly or daily basis. When loads are over- or under-estimated, costly back-up generation or spot price wholesale power purchases have to be brought into the system.

One example is that a 350–400MW unit near Boston requires a 24-hour ramp-up time and then must be run for up to four days before it can be shut down. Being able to estimate the summer peak load requirements more accurately could help to avoid unnecessary plant scheduling and related costs.

Early morning 'day before' weather data (at about 8:00–9:00 am) usually provides the best information for making the following day's forecast. Forecasts include dry bulb temperature, dew point, wind and humidity. Neural net models are generally used to generate load forecasts from the weather data.

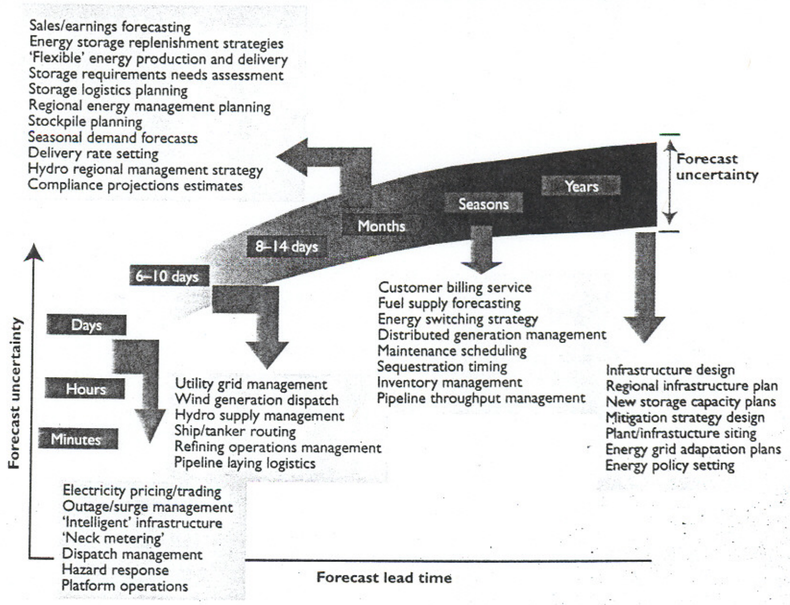
The SAIC studies have found that it is important for independent system operators, particularly in the northeast, to schedule generation for 'must run' situations, such as upcoming periods of high temperatures, if they are to avoid recourse to the expensive short-term power market. Periods of three consecutive days of 76°F or more usually necessitate grid operators bringing on line 'must run' generation plants 24 hours in advance, which then have to run for three or four days, whether or not the power is ultimately required. An improved forecast capability of three days in advance of an event of three to five days of consecutive high temperatures could therefore result in considerable financial savings.

Seasonal forecasts

Deferring capital investment asset management decisions On-going investigations indicate more precise seasonal forecasts of summer peak temperatures in California can significantly aid scheduling of substation construction and line upgrades. Scheduling capital projects is a significant part of power generators' operating cost. The ability to bring forward or defer such expenditure is important as it allows operators to schedule work to optimise their financial resources. For example, one northeast utility determined that more accurate network forecasts of next summer peak temperatures could enable it to defer expensive substation upgrades to the following year at a cost of up to $50 million a substation.

☐ *Fuel purchasing* There is a clear relationship between temperature and the energy consumption 'spend' of major state facilities.

Energy operations aided by reductions in environmental forecast uncertainty



However, many such major power users are unsure how to use weather forecast information optimally in their energy procurement strategies.

Weather has a significant impact on natural gas and electricity pricing and therefore the use of forecast information as a predictor of real-time or day ahead prices could facilitate significant cost savings. Market prices range from $20–75/MWh and occasionally during specific weather events (approximately 2% of the time), prices exceed $100/MWh.

Weather forecasts out to four days successfully gave general weather trends that could be used reasonably accurately for identifying potential load exceedences; however, by day five the accuracy of these forecasts decreases. The potential use of probabilistic forecasting to improve the accuracy for predictions beyond four days is a high priority.

Decadal forecasts

Infrastructure siting and upgrading Some current models now provide estimates of the influence of climate change on power infrastructure and strategic planning. In a recently completed investigation, a climate forecast model was constructed for southern California out to 30 years.

Strategic plans for the San Diego region's energy infrastructure were examined under different climate scenarios, one of which indicated a much higher incidence of summer temperature extremes for Southern California that would stress major infrastructure assets. A one-degree change in temperature during the summer months of May–October creates an additional 50–258MW of demand, taking into account price, customer growth and average use factors. Using a 20-year value of this demand at $1,300/MW cost would mean an additional $65 million–325 million in additional generating capacity would be required to meet climate-related demand increases.

The financial services sector

The financial services sector influences the way in which energy companies operate (eg, via its underwriting investment). The energy sector will have to respond to pressure from financial services companies to manage weather-related risk better to minimise unanticipated costs, reduce generation costs, meet environmental and supply regulatory requirements and optimise capital investment, all of which impact profitability.

The key to achieving these objectives is the enhanced use of weather forecast information to transform weather-related risk into probabilistic terms, which is both understood by the financial services sector and facilitates improved management of risk.

Conclusions

The case studies indicate that forecast information is now of sufficient accuracy to be better incorporated into decision-making processes and models. New methods are facilitating the creation of probability trends, which the energy industry will be able to incorporate into its forecast and financial models. The challenge is to use probabilistic forecast data in place of statistical forecast methods. The finance industry is used to dealing with probabilities, so a beneficial by-product of this change is likely to be more cost-effective and efficient hedging of risk.

The major challenge to energy industry operators is to enhance their skill in using environmental information. This includes awareness raising, load forecasting, financial planning, equipment design, equipment location and risk management and hedging.

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