Exposed To the Elements: Developing Customised Weather Risk Solutions for the Energy Industry

From navigation to tourism to construction, the weather is a key risk driver for many industrial sectors exposed to its variability. However, no other sector is more highly exposed to weather fluctuations than the energy industry. Swiss Re's Environmental & Commodity Markets (ECM) expert Thomas Kammann explains how weather products can help the energy industry hedge its exposure to the elements.

Most people think about the weather in terms of how warm it is, whether it's raining and so on. But for an operator of a fleet of river barges in one of Europe's busiest waterways, weather can make or break a business. To a large extent, the operator's fleet depends on the level of its barges' loading capacity, which in turn depends on river water volume and, ultimately, on the amount of precipitation.

Balancing demand and production

For the energy industry – particularly natural gas and electricity – weather has a significant impact on a firm's ability to be profitable and competitive, on both the demand and production sides.

On the demand side, natural gas is primarily used for direct heating and electricity production and – to a lesser degree – as feedstock to produce fertilizer. Electricity, in contrast, is largely used for air conditioning, adding a significant load to generation and distribution systems in many nations.

A natural gas retailer in United Kingdom may face significant reductions in operating income during warmer-than-expected winters as less gas is consumed for heating. The retailer is likely to incur additional losses when forced to sell oversupply of gas at low spot prices in the market. Conversely, an Australian utility may face sharp costs for additional electricity production during extraordinarily hot summers as the load increases exponentially with air conditioning use. During dry summers the situation may get worse as energy generation becomes subject to water restrictions, directly impacting the utility's cooling systems. Such an electricity shortage may increase market prices significantly as the supplier will be forced to cover imbalances at much higher prices than originally planned.

On the production side, faced with rocketing raw fuel costs, the energy industry has accelerated the development of environmental-friendly electricity generation techniques such as wind and solar power. However, putting together a financing structure for such projects requires a certain production volume which is strongly dependent on weather conditions such as wind speed and sunshine duration. Due to their uncertain profitability and reliance on the elements, financial institutions have often required investors to hedge-out such exposure before engaging in any type of pre-financing.

Bringing a weather product to market

The relationship between certain weather phenomena and economic profit is the driving force behind a weather protection product.

Designing a weather product requires a series of steps, including identifying applicable weather measures (ie. temperature, precipitation, wind speed or sunshine duration) and establishing an index that reflects, as closely as possible, the relationship between weather and profit.

In the earlier example of the UK gas retailer, where the main business focus is ensuring an income stream for the entire winter season rather than just for one day, the sum of Heating Degree Days' (HDDs) for a given location and period of time (1 October – 31 March) would be the most appropriate means to establish this relationship. To use this as a benchmark for the following year, the utility would need to analyse at which point the index (cumulative HDDs over a six-month winter season) strikes a value where the shrinking operating income has a negative impact. If this index is 1,900 HDDs, the most appropriate product would be one that starts to pay out when the index value hits 1,899 HDDs or lower. In addition to defining a strike value, the product designer needs to consider the tick size (eg. EUR/HDD) which defines the steepness of the curve (see Figure 1). The tick size should reflect the incremental amount of money the utility is losing each time the HDD level drops another notch below the strike value.

Dealing with “basis risk”

In financial trading terms, “basis risk” is defined as the risk that investments in a hedging strategy will not be subject to price changes in the entirely opposite direction from the original exposure. This imperfect correlation between the two investments creates the potential for excess gains or losses in a hedging strategy, adding risk to the position. In the case of weather derivatives, the basis risk varies significantly between the different types of industrial exposures.

As an illustration, the basis risk for a resort operator in a tourist driven region seeking to hedge the risk with a temperature index could be quite considerable. In fact, even when summer temperatures are likely to be high, tourists may stay away when it rains. To address such cases, weather experts can design multiple indices (eg. temperature, precipitation and/or snow height) to further reduce basis risk.

Compared with other industries, basis risk in the energy industry is typically rather small, as the correlation between temperature and energy demand is often obvious. Examples are winter gas demand in Europe or summer electricity demand in the United States or Australia. In liberalised energy markets, however, the industry faces another sort of basis risk, as weather derivatives may protect it against the volume risk associated with involuntary long or short positions but not against the price risk for such volume.

Putting quanto structures to work for the energy industry

On one hand, demand in the energy industry is – to a large extent – a function of temperature, so temperature may serve as a proxy for it. On the other hand, price is positively correlated with demand which means that, for the example of the UK utility, the warmer the winter, the lower the demand and the lower the gas price. So the utility may try to hedge out the risk of a warm winter using an HDD index, but it is hard to estimate whether the tick value of 10,000 GBP/HDD will be enough to cover all losses. Indeed, a warm winter could create an abundance of gas in the market and result in a dramatic fall of gas prices. In this case, the estimated tick value could prove over-optimistic.

Let’s assume that the UK-based utility estimates a lack of natural gas demand of 100,000 th/HDD for a warm winter. In such case they have to sell the surplus gas on the market and, for a warm winter, they expect the market price to drop by 10p/th. To hedge themselves they would buy a HDD put option with a tick size of 10,000 th/HDD x 10p/th = 10,000 GBP/HDD. Now, at the time of delivery in winter, their estimation of a demand decrease of 100,000 th/HDD proves to be right. However, the spot price decreases by 30p/th instead of 10p/th. While the HDD put paid out covers the volume losses based on a price drop of 10p/th, the additional price loss of 20p/th is not hedged.

This example shows that, particularly for the energy industry, mitigating volume and price risks in parallel is fundamental. Quanto structures, which are essentially double-triggered derivatives, are currently the instruments most commonly used by the energy industry to manage this kind of risk.

Quanto structures may come as an option type contract to protect against a concurrence of a warm winter and low gas prices, or as a swap type contract to additionally hedge against the concurrence of a cold winter and price spikes. In Europe, the structure of such a swap type contract would have the following shape:
Figure 2

This quanto structure is designed to smooth out the negative impact of adverse concurring demand/price events on a utility's portfolio. However, the successful use of this type of hedging instrument needs some market preconditions to be in place, including correlation between weather (i.e., temperature and precipitation) and energy prices (i.e., gas and electricity), as well as a liquid underlying energy market.

**Weather solutions: alternatives for the energy industry**

A significant number of industries are exposed to weather risk. The energy industry is, however, among those with the biggest exposures. Through customised, innovative weather products such as Quanto structures, the industry is now well positioned to hedge its exposure with relatively low basic risk.

In the past three years, Swiss Re has provided a number of structured weather solutions in Europe, the United States and Australia. In Australia, for example, in the first two months of 2008 electricity prices have rocketed up to 10,000 AUD/MWh due to extreme heat and drought conditions. But because weather and Quanto solutions are relatively common products in this island continent, at least parts of the energy industry have been well protected from the elements. In Europe, the UK gas market shows a converse but also a tight correlation to the weather. The United Kingdom sees a particular increase in demand for such products during the winter.

**About the author**

Thomas Kammann is a Director with Swiss Re's Environmental & Commodity Markets (ECM) team. His unit originates and trades complex weather-contingent energy structures and offers contingent power, gas, coal and heating oil products for a broad customer basis, including large financial institutions and utilities in the United States, Europe and Australia. The team consists of 14 professionals located in Zurich, New York, London and Mumbai. Based in Zurich, Mr Kammann is responsible for originating ECM solutions in Europe and Australasia.

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1. HDDs are defined as the number of degrees that a day's average temperature is below 65 or 18. This is the temperature below which buildings normally need to be heated. In Europe, for example, the number of HDDs for a given day with an average temperature of 15°C is 3 (18°C – 15°C). For a day with a temperature of 18°C or higher it would be 0.
2. One therm corresponds to 29.3 kWh
3. Instrument that pays out as soon as the index (HDD) falls below a certain threshold or strike value (1,900 HDDs).