

That exotic option called power

As a derivative of other fuels, electricity is an exotic option. Despite the downturn in energy trading activity, such complex options continue to be structured and embedded in power contracts. *Anne Ku* surveys the situation on both sides of the Atlantic

Power is complex and exotic. Electricity is a compound option – energy from a power plant is an option on the capacity, which itself is an option on the input fuels. A power plant is a spread option – the plant is profitable to run if the output power is more valuable than the input fuel and operating costs.

“Just about everything in power is exotic,” says Chris Strickland, director of Lacima Group, a provider of risk management consulting, software and training, who is based in Sydney, Australia. Some typical examples include a capacity option on a facility with path-dependent-type characteristics, swing contracts, fuel supply contracts and long-dated tolling agreements.

What makes such options exotic? Strickland points to the numerous assumptions that must be made on forward curves, volatility, and jump parameters, which make their valuation that much harder. Douglas Coyne, an energy consultant at software vendor Fame Energy’s Oxford Princeton Programme, says many exotic options do not have valuation formulas and must be priced using one of several estimation techniques.

One way of initially identifying and quantifying the optionality found in power contracts and fixed assets is to check them against certain criteria (see table, right). Exotic options mentioned in this article are explained in greater detail in the table on page 32.

The popularity of an option depends largely on the availability of its underlying price or index. For example, in the US, heat rate options allow power plant owners to hedge their plant output, which is dependent on natural gas and power prices. Limited-strike daily summer options in the Pennsylvania-New Jersey-Maryland region, popular in 1998 and 1999, allow users to exercise six times within 23 days in a month.

Barry Trayers, an options trader at Tractebel USA in Houston, Texas – a subsidiary of Belgian energy firm Tractebel – feels such financial options will become popular again only when a

reliable, independent index is produced. The previous price transparency has been reduced by various factors, including the demise of New York Mercantile Exchange electricity futures, recent controversy over certain traders rigging Platts gas prices and the shift back to voice brokering and bilateral contracts. Like many others, Trayers expects published indexes to come out of the formation of regional transmission organisations. “Once you get indexes, options can get more exotic,” he adds.

But even if such indexes become available, finding creditworthy counterparties becomes harder as the bigger energy trading firms receive credit rating downgrades. Shezad Abedi, chief executive of Bright-Spark Energy Risk Consultancy in London, sees the industry structure changing so quickly in the underlying markets that counterparties need margin to cover

non-quantifiable or non-hedgeable risk. And margin directly affects credit.

Christophe Chassard, vice-president and head of structured products at RWE Trading in London, a subsidiary of German multi-utility RWE, says the biggest impact on his firm’s business has been the departure of US energy merchants from Europe, leaving fewer counterparties to trade with. “Most of the remaining market participants have been reluctant to enter into exotic transactions because they are less transparent and more difficult to understand and/or value,” he says. “However, RWE Trading is prepared to do more exotic trades and has, in fact, experienced a noticeable increase in the volume of exotic transactions it has entered into since the start of the year.”

While the banks with better credit ratings may have picked up people from

Determinants of optionality for pricing exotic options

By decomposing an exotic option into its bare elements, such as the kind of building block – whether it’s a forward, swap, plain vanilla option, or a strip of options – market participants can determine the type of option and the appropriate valuation techniques to use.

Building block

- Forward
- Swap
- Option
- Strip of options

Long or short?

- Long
- Short

Option type

- Call
- Put
- Straddle

Quantity

- Variable
- Known or fixed
- Variable with maximum OR minimum
- Variable with maximum AND minimum

Strike price

- Fixed
- Average of underlying
- Index at future date

Exercise style

- European
- American
- Bermudan
- Swing (co-dependent)

Underlying

- Spot
- Forward
- Swap
- Spread
- Option
- Combination or multiple

Trigger event/contingency

- Weather
- Plant outage
- Transmission failure
- Other events

Payout type

- Simple (plain-vanilla)
- Digital
- Barrier
- Average
- Lookback

Derivative instruments used in power markets

INSTRUMENT	DEFINITION	EXAMPLES
Derivatives with a single underlying		
Plain vanilla option	<i>Call options:</i> the right, but not the obligation, to buy the underlying at a fixed price. <i>Put options:</i> the right, but not the obligation, to sell the underlying at a fixed price. <i>Straddle:</i> a combination of put and call with the same strike.	<i>An option contract</i> gives the buyer the right, but not the obligation, to buy (call) or sell (put) the underlying at an agreed strike price during a predefined time period. <i>Capacity</i> is equivalent to a call on the generation process, such as on a power plant. <i>Energy</i> is a call on the fuel – this is the concept of converting one type of energy into another.
Callable and puttable forwards	<i>Callable forward:</i> where the trader is long a forward contract and short a call option. <i>Puttable forward:</i> long a forward contract and long a put option.	<i>Interruptible supply contract:</i> the supplier can exercise the call option whenever the spot price exceeds the strike price, effectively cancelling the forward contract at the time of delivery. <i>Dispatchable independent power producer supply contract:</i> the customer can exercise the put option whenever the spot price falls below the strike, effectively cancelling the forward contract at the time of delivery.
Strip of calls or puts	A basket of independent options with similar characteristics but different maturities. A 'cap' is a strip of calls and a 'floor' is a strip of puts.	<i>Capacity reservation:</i> the right to have access to capacity on a daily basis for a month translates to a strip of daily calls (cap). A floor ensures generators can sell at a given price in the future without being obliged to do so.
Exotic swaps	<i>Extendable swap:</i> one that contains the option to extend a swap for a given period. <i>Cancellable swap:</i> a long or short swaption (option on a swap).	The trader enters into a one-month swap transaction but, at the end of it, has the right to extend for another month or to cancel at a particular time.
Derivatives with multiple underlyings		
Spread option	Option on the price differential between two underlying products, locations, qualities. A spread option is a type of 'rainbow' option, whose payoff depends on the prices of two correlated, but distinct underlying assets.	A spark spread is an option on natural gas and power prices. If the market price of power is more expensive than converting gas into power, then a company should burn its gas and sell its power. If power is more expensive in one region than another – including transmission costs – then exercise this option should be exercised.
Basis swing option	Swing option between two locations	A buyer takes a contract between two regions, but can change volume during the period.
Path-dependent options		
Asian option	<i>Average strike option:</i> the strike is known at the time the contract is valued. <i>Average price option:</i> the strike is set in the future as an average price of an underlying observed over a future period of time. <i>Double Asians:</i> the strike price is set at a future date – usually to the value of an index – and the payoff is based on the average of the underlying.	An inflexible power plant such as one used for base-load generation can't be switched on and off from day to day, but can be turned on one week and off the next. The decision to run it depends on the average power price for the week.
Barrier option:knock-in, knock-out	A contract that causes an option to come into existence (knock-in). A trigger event – such as a pre-set price level – activates (knock-in) or terminates the deal (knock-out).	<i>Knock-in call:</i> You gain the right to buy power if the price falls to a preset level. <i>Knock-out call:</i> You have the right to buy power at \$10 a megawatt hour (MWh), but if it moves above \$20/MWh the deal falls apart. These types of options are embedded in contracts, not traded.
Lookback options	The option holder has the right to buy or sell the underlying asset at the best possible price attained over the option's life.	<i>Floating-strike lookback:</i> an generator sells an option to sell power at the average of the five highest half-hourly prices during a particular month.
Options with variable volume		
Variable-quantity options and forwards	<i>Fixed price per MWh multiplied by variable amount:</i> these are variable quantity forwards with a delivery price equal to the fixed price of the contract. <i>Floating price multiplied by variable amount:</i> a supplier can buy spot at a future date and sell it to the client at market prices. This may include a maximum and/or minimum floating price.	
Swing	Basket of co-dependent, American-style exercise derivatives.	<i>Non-ruthless exercise:</i> a utility sells a contract to a large industrial end-user. A classic case is the aluminium smelter plant that uses either all or nothing. <i>Ruthless exercise:</i> a utility trades with another utility in the same city in the same market, with the intention of maximising profit.
Embedded swing option ('interruptible power')	Sale of a swap simultaneous with purchase of a swing option from the same party.	<i>Load-curtailement contract:</i> a utility sells industrial users a discounted swap, but the utility gets the right to not deliver power a fixed number of times in the period. This parallels a 'range forward' in the foreign exchange market.
Options on options		
Compound option	The option holder has the right, but not the obligation, to buy or sell another underlying option based on another option – that is, he could have a mother option and a daughter option. There are four possible combinations: call on a call, call on a put, put on a call and put on a put.	<i>Option on a call or put option:</i> in the energy markets, this usually takes the form of an option on a strip of options, rather than on an individual put or call option.
Compound spread option	<i>Option on a spread option:</i> an option on a strip of spread options.	Instead of building a new power plant, a utility buys a compound option from a power marketer that gives the ability to call on a second option some time in the future. The utility therefore has access to power without the risks of building or owning a power plant.

Source: Author, with Carlos Blanco of FEA, condensed from www.analyticalq.com/energy/exotic/

the energy trading sector, they still need the underlying physical liquidity if they are to trade exotics. Electronic trading platform E-lecTrade's president Anil Suri envisages energy transactions – at least for now – going back to the slow way of doing business, via request for proposals (RFPs)¹. E-lectrade was set up to address the need for structuring and customising trades online.

The RFP process allows a case-by-case arrangement of credit and removes the potential for round-trip trading. Because RFPs take the procurement function out of the hands of the traders, they eliminate the layers of buys and sells that can be also 'round trips'. Round trips are instantaneous buys and sells of equal amounts whose sole purpose is to inflate revenues.

As the market recovers, it is likely to seek solutions that provide credit support along with transparency, in a type of a modified RFP process. Suri believes exotics will stay, given the complexity of serving electricity as a commodity, but that they will be largely unhedgeable.

So it certainly seems that the drying-up of liquidity does not spell the end for the power trading business. Petros Fanis, a senior options trader who operates in oil, gas, coal and electricity markets at EDF Trading in London, a subsidiary of French firm EdF, feels the current liquidity crisis is a result of companies that over-expanded and are now returning to their core business. This boom-and-bust cycle has happened in other markets.

Hedging

Nevertheless, the less liquidity there is, the more difficult it is to hedge or lay off risk. The majority of merchant power assets have life spans of 20 years or more, but most are hedged for only the first two years, as there is no liquid long-dated market.

David Goodman, director of power trading at Entergy-Koch Trading (EKT) in Houston, says firms that divest themselves of their trading and marketing capability will still have asset risk on their books. "When you take on a physical asset, such as a power plant, you inherently have risk," he says. "Trading allows you to hedge out near-term risk, while origination [marketing] allows you to hedge out the long-term risk, which is less liquid."

Lacima Group's Strickland says firms became more aware of their risks after Enron's collapse took away the liquidity



Anil Suri,
E-lecTrade: exotics will remain in use, but will be largely unhedgeable

of standard products. "Companies, especially the smaller players in generation and retail supply, are looking at the risks more closely now," he says. "End-users are also looking for more structured-type trades, as they are exposed to power prices and other factors."

Exotic options embedded in insurance products have also appeared on the scene. Global group Swiss Re's forced outage insurance – Electricity Price and Outage Solutions (Elpro) – behaves like a contingent call option, and the call is available only if there is a forced outage or forced derating. Elpro protects generating units from the operational risks associated with the price of electricity.

Exotic needs of end-users

Liquidity of wholesale power trading aside, end-users of power, too, have specific requirements and usage patterns that standard tradable options cannot meet. For this reason, it is common for exotic options to be automatically embedded into retail power transactions. Lance Hinrichs, a Houston-based consultant, summarises the situation as follows.

Utilities often give discounts to big customers who allow them the right to interrupt service in periods of extreme prices. Such call options on power prices can be physical, where the end-user must curtail consumption, or financial, where the end-user can continue its consumption but must pay the hourly spot price.

Similarly, some end-users can 'fuel switch' when it is economically advantageous to do so. For example, they switch diesel or gas for electricity at facilities with on-site power generation capabilities. Others have industrial processes that allow switching. Fuel switching is an option on the spread between power and another source of fuel.

Third-party power marketers often exercise 'rainbow' options in transitional markets by annually choosing whether to physically or financially serve their long-term customers. To physically serve, they schedule customer load, procure wholesale power and transmit to a utility distribution firm. To financially serve, they get service through the utility and pay for the service on the customer's behalf.

Exotic options are also used in modeling generation assets, in what's known as the 'real option' approach. For example, a gas turbine unit with almost instantaneous response to market signals can be treated as a portfolio of daily spark spread options, with some caveats. Victor Belyaev, a quantitative analyst at PG&E National Energy

Group in Bethesda, Maryland, says a power plant's flexibility affects its option value. While combined-cycle units are more efficient than peaking units, their slower response to market signals means they should be modelled as options with a continuous daily path-dependent payoff.

Plant features that reduce the value of options include minimum up and down times, contractual restrictions and limits on the total number of starts in a certain period. Features that increase option value include fuel-switching capability or rainbow optionality, duct-firing capability and the ability to sell power into different pools in the absence of transmission constraints.

The purpose of exotic options is pinpointed by Carlos Blanco, vice-president at FEA, a software firm in California. He says: "Exotic options, when properly structured, hedged and understood, provide power market participants with a potent tool, giving them the flexibility to manage and transfer inherent business risks to other parties with natural offsets or different degrees of risk tolerance."

Shmuel Oren, professor of operations research at the University of California in Berkeley, has done research work motivated by options in contracts, such as interruptibility of service. He says: "Nobody thought thoroughly about how to manage risk along the supply chain of a vertically disintegrated electricity industry. The way to do it is through a variety of financial instruments tailored to hedging needs.

"A forward contract, for example, is not a good hedge for a generator selling its power output," says Oren. "A better hedge is selling a spark spread put option, which accounts for the generator's real option of shutting down when it is not economical."

E-lecTrade's Suri agrees that such customised structures are sorely needed. However, he warns that the high volatility of electricity may not be hedgeable simply with financial instruments or even physical instruments if the underlying design of the power supply chain is flawed. "The supply chain of risk has to mirror the physical reality of electricity supply," he says. "End-users vary their electricity usage at will, and that variable-usage shock is felt all the way back at the generating station.

"Unless the industry finds a way to rationalise that risk in a deregulated environment, history will repeat itself, leading to more financial losses," adds Suri. "Over the next few years, innovative deal structures will surface to rationally price and allocate the unique risk of power supply. That just means there are even more exotics to come." **EPRM**

¹ An invitation for providers of a product or service to bid on the right to supply that product or service to the individual or entity that issued the RFP.