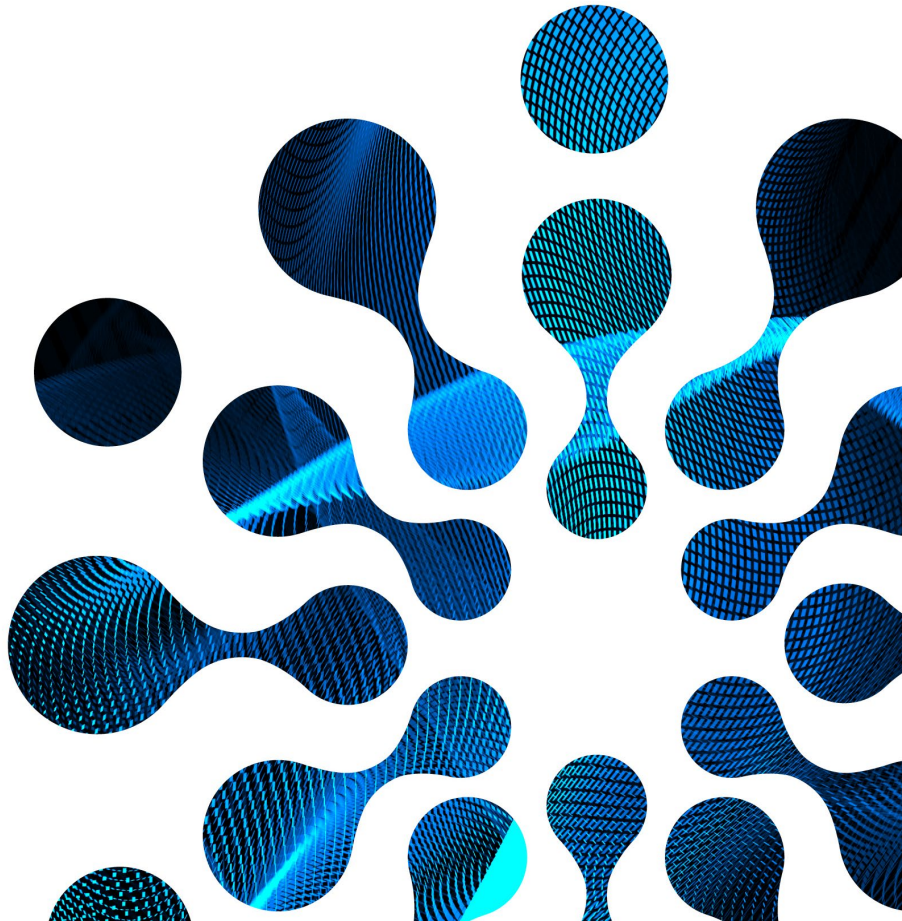
Weather and Forced Outage Product Education Session

November 2022



CQENERGY
Part of the energyone group

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CQENERGY

Who we are/Australia

- CQ Energy are part of the EOL group have worked as brokers in the Australian power markets since 2008
- CQ/RSI are a specialist joint venture group focussed on broking weather and forced outage products and synthetic PPA's
- In their role as brokers in Australia CQ/RSI help their clients structure transactions, take them to market and work with them to transfer risk to third parties

- The Australian power market is an energy only market (no capacity payments) and as such has a market price cap of $15,100/MWh and a price floor of -$1,000/MWh
- The Australian power market has historically been one of the most volatile global commodity markets and heavily influenced by weather outcomes and loss of generation capacity during high demand periods

European context

- We understand the larger utilities have traditionally purchased weather products
- Their focus has previously been on managing warm winter risk to manage loss of revenue related to retail gas customers
- Due to recent events buyers have reverted to managing cold winter and commodity price (electricity/gas price) risk
- Products to manage lack of sunshine and wind have been purchased in various European markets
- Forced outage products (both for gross pool and net pool - capacity markets) are now attracting interest in Europe – Italy currently a target market

Weather Products - What are they in concept

- Products to manage weather risks were developed by Enron in the 1990s
- Applicable across any industry or commodity where revenue/price outcomes are influenced by weather
- Structures include some form of weather event which must occur to potentially trigger a payment
- The payments can take the form of a fixed payment or as a function of a commodity price outcome
- Structures can have daily and term limits
- Significant demand in the energy sector and includes energy risks related to solar, wind and precipitation (hydro)
- Structures can take the form of puts, calls, collars, swaps and options as in other financial markets
- In terms of limits these are at the request of the buyer and can typically be up to $30M (sellers could offer up to $100M)
- The structures are all bespoke and are structured around the risk profile the client is trying to manage

Many industry sectors have exposure to weather

Industry	Weather Risks
Natural Gas Utilities/ Retail Providers	Revenue Risk from Warm Winter Supply Price Risk from Cold Winter
Electric Utilities/ Retail Providers/ Power Plant Owners	Revenue Risk from Warm Winter/ Cold Summer Supply Price Risk from Cold Winter/ Hot Summer Unit Outage Risk
Wind Generators	Revenue Risk from Lack of Wind
Hydroelectric Production	Revenue Risk from Lack of Precipitation/ Streamflow
Solar Generators	Revenue Risk from Lack of Sun Exposure
Agriculture (Farmers, Food Processors, etc.)	Cold, Heat, Excessive or Lack of Precipitation
E&P Companies	Freeze offs/ Price Risk/ Reserve Risk
Municipalities/Councils	Energy Consumption/ Snow Removal/ Water
Construction	Precipitation/ Extreme Temperatures

Who sells them

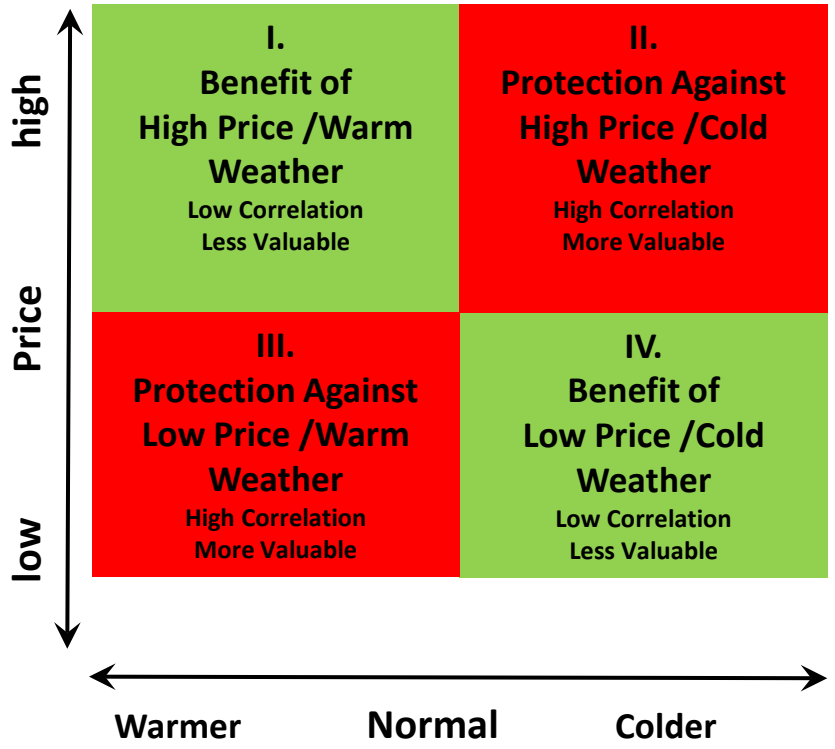
- Sellers of these products are typically large re-insurance companies or private equity funds where they are looking for diversity away from their core business (i.e. events in the weather markets are non-correlated with say earthquakes, hurricanes or share market outcomes)
- There is around 12 to 15 active sellers of weather related structures globally
- From a credit perspective sellers are S&P A- rated or better with a number using fronting providers such as banks for credit purposes
- Structures can be closed in derivative or insurance form with most closed as derivative due to lower on-costs such as stamp duty in some jurisdictions
- If closed in insurance form there has been agreed/parametric settlement clauses to avoid proof of loss requirements as typically required as part of an insurance contract

Essential ingredients of weather hedging

Winter and Summer Example Structures

	Customer concern		Product offers
Natural gas distributors & retailers	**Warm winter**: not selling enough gas to meet expected return on capital and potentially too much gas purchased at fixed prices (take or pay issues)	⇨	**"Volumetric hedge"** – pays client if winter is warm (low sales), using weather-only products AND/OR **"Over-supply hedge"** – protects client against risk to have to sell excess gas at low price
	Cold winter: not having enough gas to meet peak daily demand, buying at high prices	⇨	**"Supply hedge"** – pays customer on cold days when price is high to make up for margin erosion
Power producers and sellers	**Cool summer**: not selling enough electricity to meet expected revenue	⇨	**"Volumetric hedge"** – pays customer if summer is cool (low sales), using weather-only products
	Hot summer: not having enough capacity at peak hours, buying at high prices	⇨	**"Supply hedge"** – pays customer when demand and price spike

Combining volumetric risk and price risk



- Structures can be bought/sold on each of the quadrants to manage risk and/or monetize positions
- Structures on each quadrant can be executed individually or in any combination

Fixed Tick/HDD

Structure (Cumulative HDD Victoria – Non-Linear Put)

Weather Reference: Moorabbin Airport published by BOM (station 086077)
Temp Definition: Heating Degree Day (HDD) – 18C Ave Temp Index
Risk Period: 1 June 2023 to 31 August 2023
Type: Buyer Put Option
Trigger: Cumulative sum of HDD over the risk period

HDD Trigger: <532

Payout per HDD < HDD Trigger:

>=525: $50,000
>=520: $75,000
>=515: $100,000
>=510: $125,000
>=505: $150,000

Contract Limit: $5,000,000

Quantos

Structure (Extreme Temperature)

Product: Weather Contingent Price Cap
Weather Station: Bankstown (066137)
Weather Strike: >=39.0C Daily TMax
Risk Period: 1 January 2023 to 31 March 2023
Period: All hours
Notional Quantity: 50MW
Price Variable: New South Wales Five-Minute RRP
Price Strike: $300/MWh

Five Minute Settlement: = If Bankstown Daily TMax >=Weather Strike and New South Wales RRP >$300/MWh then,

=50MW * (RRP- $300) * 1/12

Deductible:	Nil
Daily Limit:	$2,500,000 (approx - 3 hours Market Price Cap – i.e. 3 * 50MW * $15,500/MWh)
Term Limit:	$7,500,000 (as above - 9 hours)
Non-Binding Indication:	$1,675,000 (64% of standard market $300/MWh cap)
Assumed cross price:	15MW @ $24.00/MWh

Precipitation

Structure (Put on Precipitation)

Term:	1 January 2023 to 31 December 2023
Weather Station(s):	Albury (072160) Benalla (082170) Falls Creek (083084) Hunters Hill (082139) Mount Buller (083024) Mount Hotham (083085)
Weather Index (mean):	0.84 * Albury 0.62 * Benalla 1.62 * Falls Creek 1.17 * Hunters Hill 0.76 * Mount Buller 0.99 * Mount Hotham

Structure (Put)

Put Term Limit:	$10,000,000
Put Strike:	567 (mm of rainfall)
Put Exit:	467 (mm of rainfall)
Put Tick:	$100,000 (per mm of rainfall)
Settlement Formula:	Daily Index = [0.84*Albury+0.62*Benalla+1.62*Falls Creek+1.17*Hunters Hill+0.76*Mount Buller+0.99*Mount Hotham] / 6

* Could use run of river flows as a function of MWh generated to determine the index and the strike

Wind

Structure (Put on Lack of Wind)

Term:	1 January 2023 to 31 December 2023
Wind Data:	Hourly wind speed data from on-site turbines (could be satellite observations)
Hourly Wind Output:	Wind Data * Power Curve * Number of Turbines
Hourly Wind Strike:	150 MWh (greater than P50)
Tick:	$100/MWh
Hourly Payout:	If (Hourly Wind Output < Hourly Wind Strike), then:
	(Hourly Wind Strike – Hourly Wind Output) * $100
Daily Limit:	$1,000,000
Term Limit:	$10,000,000

Solar

Structure (Put on Lack of Solar)

Term:	1 January 2023 to 31 December 2023
Weather Data:	Irradiance: global radiation determined by Merra 2
Production Output:	Weather Data * Plant Capacity * Performance Ratio
Daily Production Strike:	3,600 MWh (greater than P50)
Tick:	$100/MWh
Daily Payout:	If (Daily Solar Output < Daily Solar Strike), then:
	(Daily Solar Strike – Daily Solar Output) * $100
Daily Limit:	$1,000,000
Term Limit:	$10,000,000

Risk Solutions International

Forced Outage Products

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RSI International

Background and recent developments

- The product has a history in Australia going back to 1999
- Outages are a major theme at present and a large driver of volatility – in June our market had about 25% of 23GW of coal capacity simultaneously offline over several days
- Outages illustrate the presence of risk all year round and we also see:
  - Elevated prices across the board; *
  - Delays and overruns to planned maintenance, catching up from COVID-19 impacts;
  - Instances of maintenance extensions (due to unexpected issues) and start up failures;
  - Fresh outages, particularly in QLD in early November

* For instance, NEM average spot prices in Q2 and Q3 were $264/MWh and $216/MWh respectively (compared with $85/MWh for Q2 and $58/MWh for Q3 in 2021). In Q3 just gone, 24% of all intervals exceeded $300/MWh, previously seen as the threshold for capacity pricing

Applications and buyers

- Cover can be used in energy or capacity markets, with the payout tailored to the particular market
- In derivative or insurance form, a highly rated risk-carrier provides forced outage cover in return for an upfront payment
- Coal and gas generation have historically been the main applications, and also pumped hydro, with newer applications in wind and solar and, looking ahead, battery
- Buyers have been limited to owners/operators of the plant in the main, where incentives aside, only they have the necessary data for underwriting and settlements
- The product can be used to defend existing contracting or allow additional contracting by releasing contingent capacity and protect against lost revenue
- The typical scenario is a short sharp outage at the wrong time but the product can also be used to manage longer term impacts
- More recently with renewables it is possible to combine cover for outages and low wind or solar resource (i.e. weather risk), a hybrid product, particularly useful for offtakers/retailers to manage variability

Covered events

- Covered events divide into unplanned outages and unplanned deratings
- Definitions are then based on corresponding IEEE classes – classes 0-3 for outages and 1-3 for deratings

Table B.1—State transition matrix

FROM State	TO State								
	Class 1	Class 2	Class 3	Class 0	Maintenance	Planned	Extended	RS	Derating
Class 1 Unplanned Outage (Immediate)	Yes	No	No	Yes	Yes	Yes	No	Yes	
Class 2 Unplanned Outage (Delayed)	Yes	No	No	Yes	Yes	Yes	No	Yes	
Class 3 Unplanned Outage (Postponed)	Yes	No	No	Yes	Yes	Yes	No	Yes	
Class 0 Unplanned Outage (Starting Failure)	Yes	No	No	Yes	Yes	Yes	No	Yes	
Maintenance Outage	Yes	No	No	Yes	Yes	Yes	Yes	Yes	
Planned Outage	Yes	No	No	Yes	No	Yes	Yes	Yes	
Extended – Planned or Maintenance	Yes	No	No	Yes	No	No	Yes	Yes	
Reserve Shutdown (RS)	Yes	No	No	Yes	Yes	Yes	No	Yes	
D1 – Derating Immediate	*IEEE Std 762 does not recognize transition to/of deratings from/to other event types except as shown.*								No
D2 – Derating Delayed									No
D3 – Derating Postponed									No
D4 – Derating Maintenance									Yes
PD – Derating Planned									Yes
DE – Derating Extended									Yes

- These centre on timing and control or lack of control with mechanical breakdown being the most common cause but not the only cause

Payout and structuring

- The settlement or payout is determined by notional quantity and spot price (specifically spot price in excess of the strike) for each applicable trading interval, usually from the start of the event rather than being deferred
- Considerations for structing include:
  - Assets – portfolio to single asset, single region to multiple regions;
  - Term – 1-2 years or particular quarters or other periods (e.g. relating to planned outages);
  - Events – Forced outages only or forced outages and deratings;
  - Notional quantity – equal to all or part of the station/unit's capacity;
  - Deductibles or retention – e.g. MW or $;
  - Price strike – previously $300/MWh as standard but now between $500/MWh and $1,000/MWh, in line with other traded products;
  - Duration – time limits based on single events or overlapping events
  - Payout limits – typically $10-20M, depending on size of the program

Addendum – IEEE definitions

- A Class 0 outage represents a start-up failure – an unsuccessful attempt to place the unit in service.
- A Class 1 unplanned outage requires immediate removal from the existing state.
- A Class 2 unplanned outage does not require immediate removal from the in-service state, but requires removal within 6 hours.
- A Class 3 unplanned outage can be postponed beyond 6 hours, but requires that a unit be removed from the in-service state before the end of the ‘next’ weekend.
- Equivalent definitions apply to deratings, except for class 0

Questions/Contact

- Questions?

- For any follow up questions and enquiries please send to: energyrisk.info@energyone.com