Swiss Re
Corporate Solutions

Weather and Outage Risk for Utilities

London Power Forum November 2014

Stuart Brown, Head Origination, EMEA APAC

SWISS RE
150
YEARS

Agenda

- What is weather risk management and why do firms do it?
- What are the products? Is this insurance?
- Some case study material
  - selling beer
  - selling home heating
  - risk in the construction business
- Outage protection products

What is weather risk management and why do firms do it?

Who has weather exposure?
Nearly every kind of firm can suffer from adverse weather

Consumer Goods

Sales of beer or ice cream (eg) are highly correlated to temperature. Marketing specialists know the relationships very well, and use the data to manage their weather risk, often through supply chain relationships

Travel and Leisure

Tour operators use weather promotions to attract new business

Resort business is affected by weather – ski stations need snow; beach resorts need sunshine

Retail

Weather drives foot traffic through shopping centers

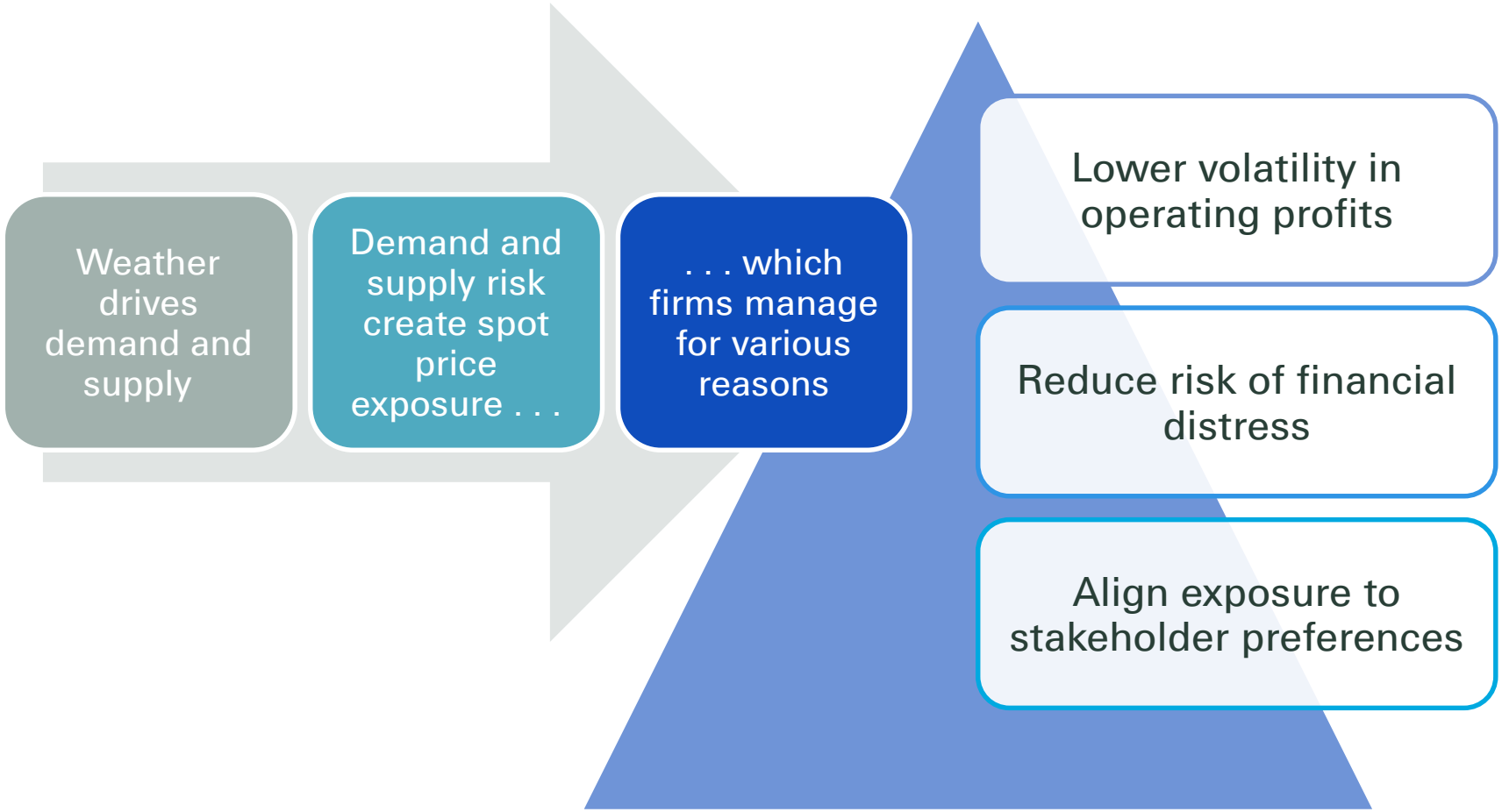
Retailers use promotions to push product

Construction

Adverse weather limits work at outdoor sites, creating direct and indirect expenses for contractors

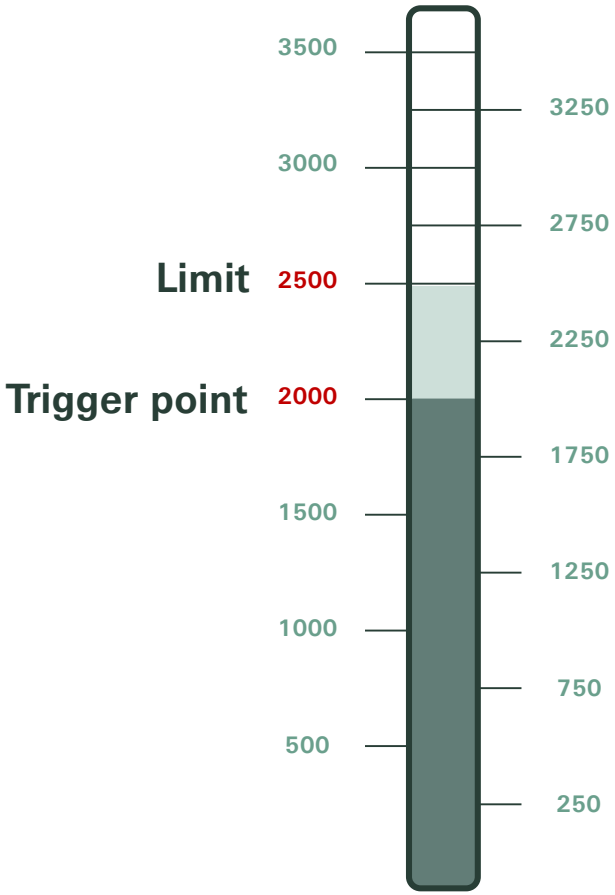
All of these industries – and more -- use weather protection to manage their exposures

Energy firms are particularly exposed
Weather risk equals price exposure



What are the products? Is this insurance?

A weather product has two elements
You need an index, and a payout formula

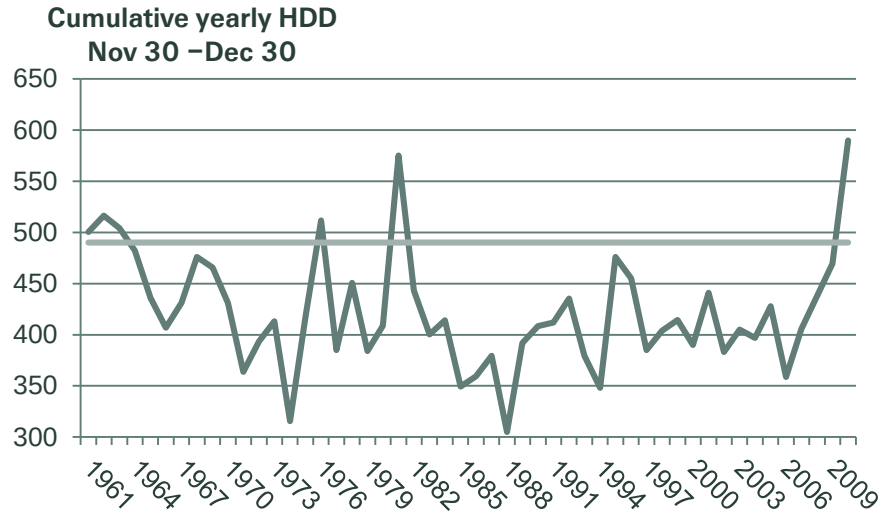


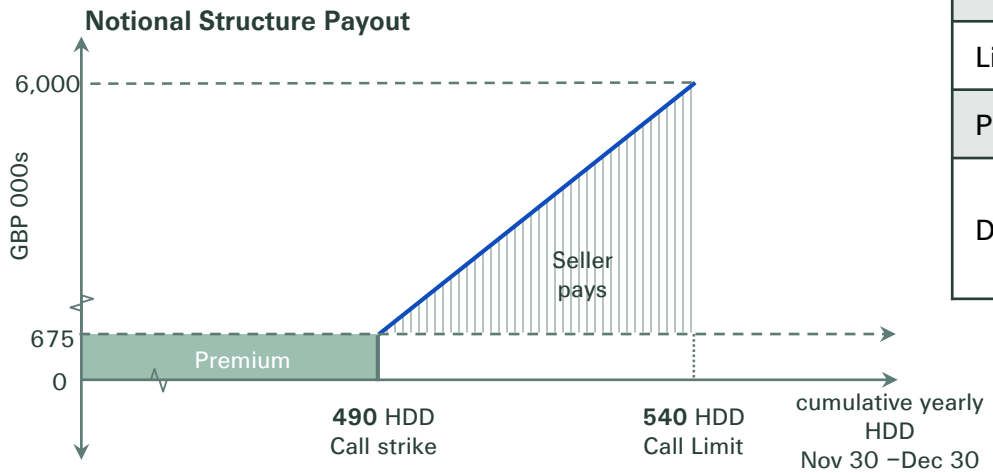
Payout based on index levels provides recovery that hedges the risk

Weather Index

- HDD: The number of degrees below 18° Celsius in average temperature per day
- CDD: The number of degrees above 18° Celsius in average temperature per day
- Customised Index: based on cumulative weather variables (temperature, precipitation, irradiation, etc) with a fixed payout per index unit.

Let's begin with a problem
Cold December hurts beer sales





Weather index	Temperature Based - Heating Degree Day
Weather Station	Birmingham, UK (Coleshill)
Heating Degree Day (**HDD**)	The number of degrees below18° Celsius in average temperature per day
Risk period	30/11/2011-30/12/2011
Strike (Floor level)	**490** HDD, which represents a **10-year** return period for harsh UK winter
Tick value	£ 120,000 per HDD
Limit	**£ 6,000,000**
Premium	£ **675,000** annually
Description	Protection Seller will pay Protection Buyer £120,000 for each HDD above the strike, subject to a maximum amount of £ 6,000,000

Guide to structuring weather protection

Attribute	Definition	How to determine
Attachment point	The level of temperature or rainfall at which the protection buyer needs to be paid for the risk of profits not being realised	Typically, the level at which cash flow failure becomes problematic
Payoff pattern	Recovery formula once the protection is triggered. The recovery is either index points times a fixed unit cost or times a commodity price vs a strike	Based on exposure: what happens when it's too warm and gas (eg) is very cheap?
Limit	The total amount of payoff the protection buyer can receive	How much is needed to replace the economics of lost profits
Type of protection	Swap – fixes the level of revenue from an asset with a contract for differences Floor – the most common structure, which establishes a minimum level of revenue Collar – like a swap, but has both a cap and a floor	Economics and buyer preference

Understand insurance?
Then you understand weather derivatives

Options/derivatives/protection	Insurance
Index trigger level	Peril covered
Strike level	Attachment point / retention
Payoff	Claim
Tick value	Size of loss
Premium	Premium
Limit	Limit

Weather as Offshore construction risk

Offshore construction risk
An example of a New Product in a fairly New Market

- Project delay is one of the most dramatic risks

- Prolonged periods of bad weather lead to project delay
  - Stand-by costs
  - Penalties for delayed completion
  - Foregone revenue from delayed beginning of power generation

- Construction projects are impacted by several weather phenomena
  - *High impact:* High wind speeds and wave heights
  - *Low impact:* Precipitation and low temperatures

Offshore weather application
Workwindow put to hedge cost overrun risk

Exposure: Adverse weather increases project cost

- Offshore construction requires continuous mild weather
- Weather slowdowns idle costly equipment
- This exposure is shared between developer and contractor, not always efficiently or transparently

Solution: A "workwindow" floor

- Workable weather conditions are defined based on weather parameters and time, eg: wave height less than 1m for 18 hours constitutes a "workwindow"
- Independent data source counts workwindows during job period
- Insurer pays client for shortfall of workwindows at agreed rate

Structure	
Product	Construction workwindow floor, or put
Risk period	Set to match construction schedule
Reference location	Lat/long coordinates matching job location
Data source	Independent provider of gridded offshore data
Weather underlying	Pre agreed as eg: wave height, windspeed
Construction hour	Acceptable levels of Weather underlying
Construction window	Number of consecutive Construction hours
Index	Count of non-overlapping Construction windows during risk period
Strike	Number of workwindows
Tick	Pre-agreed
Limit	Pre-agreed
Payout	Min(Max(Strike − Index, 0) * Tick), Limit

Sample costing: EUR 5mm limit / 250,000 tick / workwindow set as combination of windspeed, wave height and wave surge distance. Attachment point (strike) set based on 10-year historical average

Construction Window (in hours)	12			18		
Attachment point	Mean	- .5 std	-1.0 std	Mean	- .5 std	-1.0 std
Attachment point in Windows	141	135	129	87	83	80
Premium in EUR	2,250,000	1,570,000	1,100,000	1,750,000	1,210,000	950,000

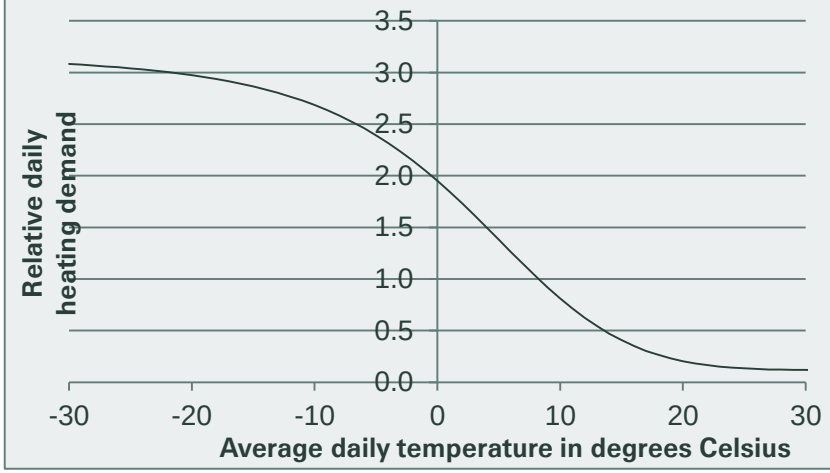
For utilities, issues are demand and price
Warm winter equals low gas demand

- Heating Degree Day products can also protect against the risk of low gas sales in a mild winter

Example: Mild Winter Protection

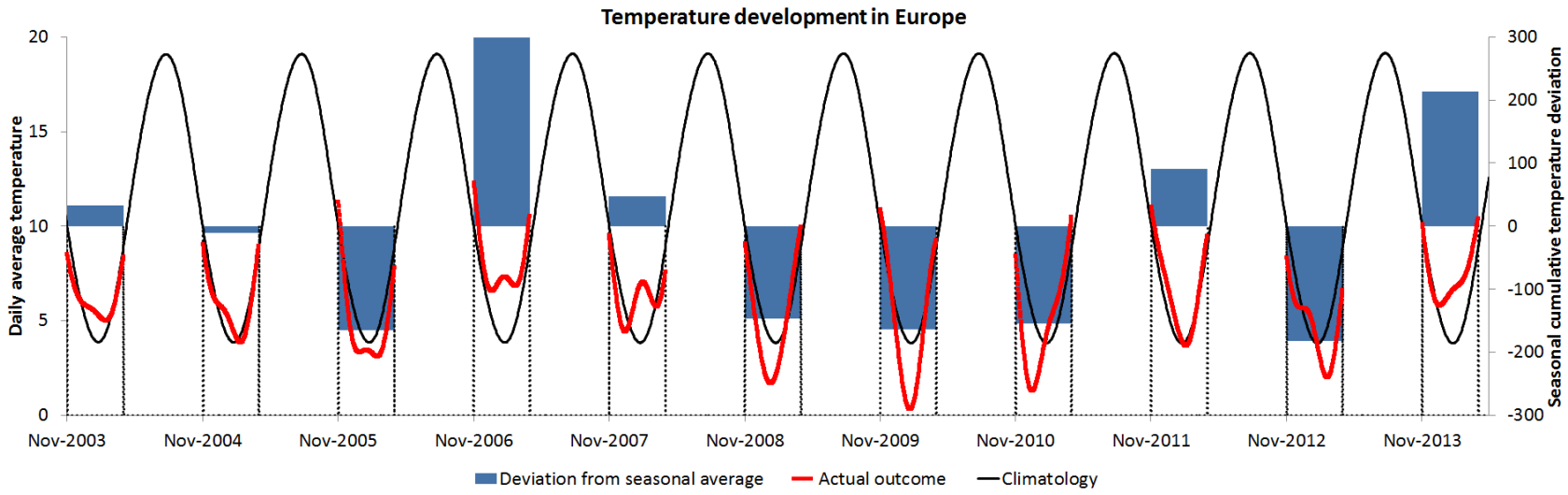
- Gas sales for home heating are a function of temperature
- Warm winter = loss of revenue

Relationship between temperature and heating demand



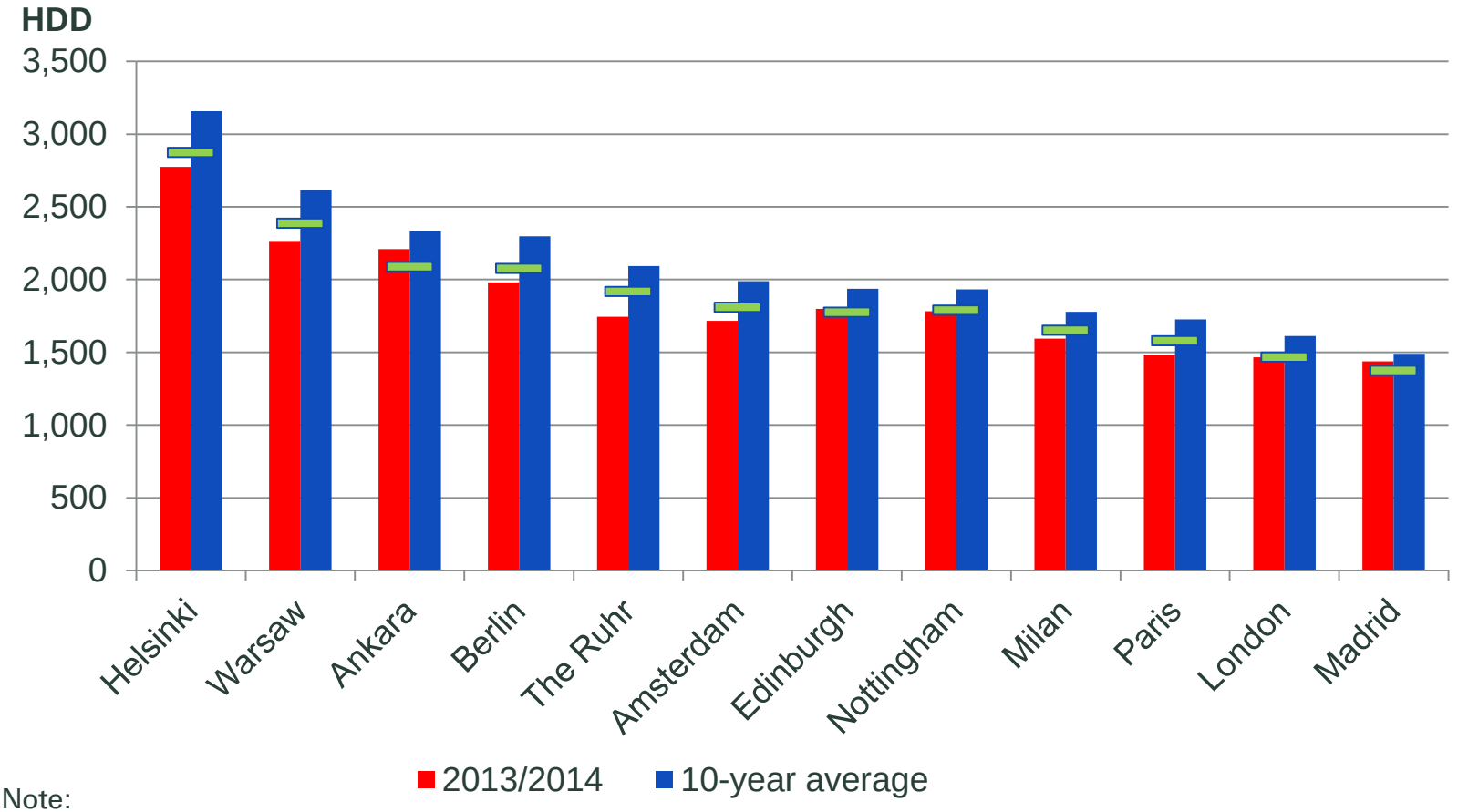
Winter 2013-14 was Europe's warmest in a while

- After several years of rather cold winters, the winter of 2013-14 was very warm
- Q1 2014 was at its warmest since 2006



Note:
Temperatures are stated in degrees Celsius
Chart reflects average daily temperatures measured at weather stations in Paris, London and Essen

All major cities throughout Europe were affected



Note:
HDDs calculated as: max(18°C – average daily temperature;0)
Green bar shows HDD level at10-year average minus one standard deviation

Unhedged firms suffered in Q1 2014

Nick Luff, CFO Centrica, Q1 2014

Q: And can you explain your new earnings guidance? Does that represent a profits warning?

A: Well, we are lowering guidance for earnings, for 2014, for Centrica. That's come about for two principal reasons. One, the warm weather in the UK, of course that's meant we've sold less gas, it's good for customer bills, but of course it does mean that we earn less profit.

And in North America, in contrast, it's actually been exceptionally cold. Normally that would be quite a good thing for the business, in terms of profitability. But it's been so cold that we have incurred some additional costs, in order to meet the demands for gas from our customers.

Bernhard Günther, CFO RWE, Q1 2014

This marked reduction can be attributed to our gas business: the predominantly weather-related declines in sales volumes caused revenues to collapse by 20% to **€4.6 billion**.

The decline in wholesale gas prices caused by the weather had negative consequences for us: we had to adjust the valuation of the gas that we had stored in Germany and the Netherlands downwards as at the reporting date.

Bloomberg Businessweek, Q1 2014

GDF Suez Earnings Decline 16% After Mild Winter Curbs Gas Demand

By Tara Patel April 28, 2014

GDF Suez SA (GSZ)' s first-quarter earnings fell 16 percent as a mild French winter cut demand for fuel for heating from the owner of Europe's biggest natural-gas network.

Earnings before interest, tax, depreciation and amortization slid to 4.2 billion euros ($5.82 billion) from 5 billion euros a year earlier, the utility based in Courbevoie outside Paris said today in a statement. The result compares with the 4.28 billion-euro average of nine analyst estimates compiled by Bloomberg. GDF affirmed its full-year forecasts.

The drop "is mainly explained by the unfavorable impact of weather on natural gas sales," it said in the statement. The utility also suffered from lower European power prices, it said.

GDF Suez, operating installations from atomic reactors in Belgium to offshore platforms and wind

Demand and price hedges paid out significantly

- Structures meant to hedge against warm winter exposure paid out, especially when based on Q1 2014 temperatures
- Weather products were a reliable partner in hedging demand and price volatility in European markets

Deal type	Geography	Premium (USDm)	Limit (USDm)	Payout (USDm)
Temp/gas price	Germany	1.7	11.0	4.9
Temp/gas price	Germany	3.1	20.6	7.7
CWV	UK	5.0	28.4	5.8
Temp/power price	UK	2.9	18.4	5.9

Offshore wind
What are the risks during the construction phase?

- Physical damage, project delay and resulting forgone revenues are the main risks

Nysted offshore wind farm (Denmark)	Korea Electic Power Corporation	Stand-by time of construction vessels
Physical damage and business interruption led to a loss of EUR 20m	400MW sea cable damaged while trenching. Repair costs USD 30m, undefined loss of revenue	Daily cost of construction vessels standing by between EUR 125k to 600k

- Bad weather leads to project delay and loss of profit
  - Stand-by costs
  - Penalties for delayed completion
  - Foregone revenue from delayed beginning of power generation
- Construction projects are impacted by several weather phenomena
  - *High impact:* High wind speeds and wave heights
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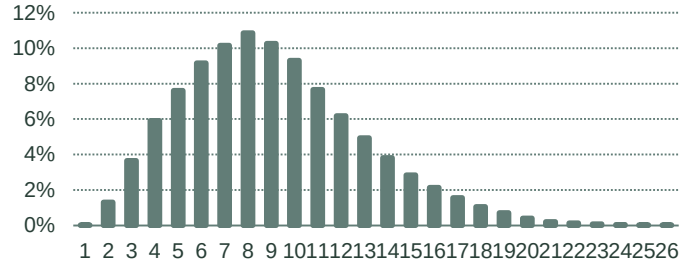
Offshore wind
How can the Weather Down Time be insured?

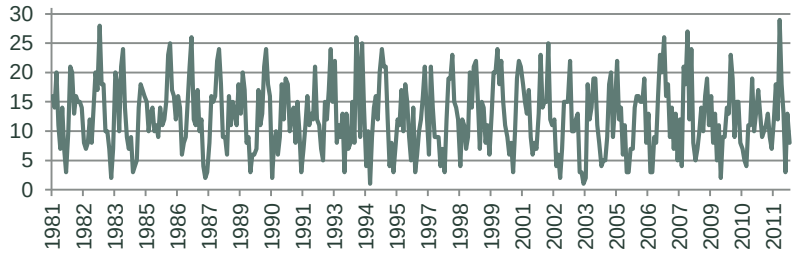
- A Critical Day is defined as a day on which wind speeds / wave heights exceed pre-agreed thresholds and construction vessels therefore are on stand-by
- The cost of bad weather is proportional to the number of 'Critical Days'
- Payout of weather protection is calculated as:
  Number of Critical Days * Cost per Critical Day – Retention

North Sea example:
Hourly wind speed distribution – historical m/s



Source: 3Tier weather data

North Sea example:
Monthly number of days with average wind speeds exceeding 8m/s



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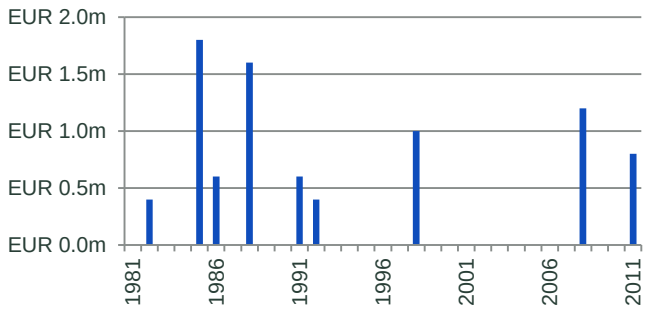
Deep dive: Offshore wind
Sample term sheet

Risk Period	1 June 2013 – 31 August 2013
Location	Operating area defined by latitude / longitude
Critical Day	Day on which average wind speed threshold is exceeded
Wind Threshold	8m/s (daily average) (Could also include Wave Height threshold)
Cost per Critical Day	EUR 200'000
Retention	25 days
Payout formula (see example below)	Number of Critical Days * Cost per Critical Day - Retention
Premium	EUR 400'000
Limit	EUR 3'000'000

Example payout scenario

Parameters	**Example: 2008**
Risk Period	June-August
Critical Days	31
Retention [in Critical Days]	25
Cost per Critical Day	EUR 200'000
Payout	(31-25)*200'000 =EUR 1'200'000

Historical payout of this structure



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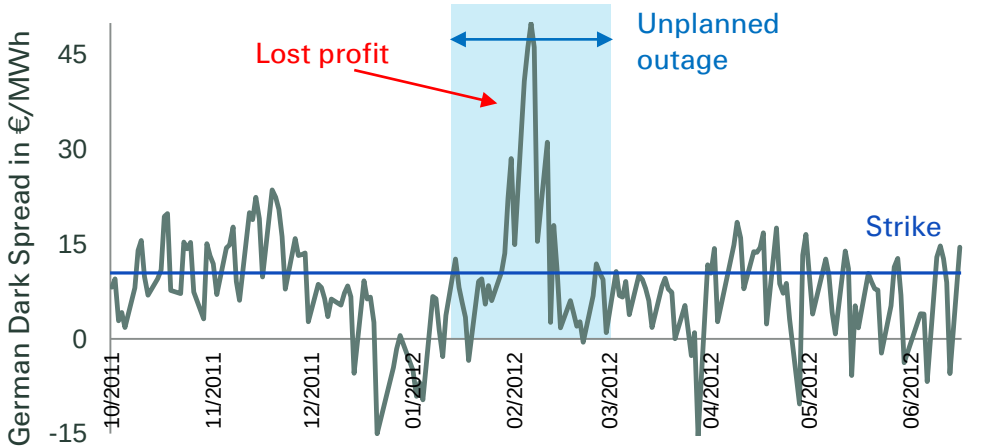
Electricity Price and Outage Risk (ELPRO)
Cover for power plant outage and price risk

- In case of an outage, power producers face two kinds of risk which are difficult to hedge simultaneously:
  - Volume risk, i.e., forgone power production
  - Price risk, i.e., price at which power could have been sold and now potentially has to be bought to meet contractual obligations
- ELPRO can be written for an entire fleet of power plants and increases financial stability, especially when the power plants have become less reliable

- ELPRO pays out when one (or several) power plants experience a forced outage and the relevant margin (or market price) exceeds a defined threshold
- In essence, ELPRO provides protection against forgone profit in case of an outage

Example: German dark spreads
(electricity price – cost of power production with coal – CO2 charge)



Electricity Price and Outage Risk (ELPRO)
Example Term Sheet: UK Generation Portfolio

Counterparty	UK Generator: Thermal Fleet approx. 7'000 MW
Qualifying Events	Outage Only (could otherwise also include derate)
Event Duration Cap	44 Calendar Days
Time Deductible:	25 Calendar Days
Determination Period:	January 1, 2010 – December 31, 2010
Hours Covered	24 x 7
Settlement Index:	UK Power LEBA 8-9am Day Ahead Index
Strike Price:	For Coal Plants: Clean Dark Spread
	For Gas Plants: Clean Spark Spread
Payout Function	(Settlement Index – Strike Price) * (Event Duration – Time Deductible)
Payout Limit	GBP 30,000,000 per term
Term Premium	GBP 3-4m
Notional Quantity	7'000 MW
Share of Program	100%

A similar protection is feasible for nearly any type of power plant

ELPRO Utility Client – Bespoke Seasonal Coverage

Summer Season Cover

- 01 June to 31 August = 90 days
- Aggregate Period
- $400,000,000 USD
- System wide coverage (11)
- Waiting period 48 hours
- 60 days event duration
- 8456 MW xs 600 MW
- Covered unplanned Events
  - Start up failure
  - Forced outage – Immediate
  - Forced outage – Delayed
  - Forced outage – Postponed

FORCED Event Report for June to August, 2014

UNIT	Event Start	Event End	Event Duration	Event Num	Event Type	Derate Amt.	Cap Avail	Cause Code	EventDescription
Monroe 1	02-06-14 14:15	02-06-14 15:15	1.00	56	D1	30	800	8099	'A' SCRUBBER LIME FEED PLUGGED
Monroe 2	17-06-14 4:30	17-06-14 6:40	2.17	61	D1	60	770	30	COAL FEEDER TRIPPED; BELT SLID; FEEDER
Monroe 2	11-06-14 13:25	12-06-14 5:05	15.67	39	D1	20	810	250	C-A COAL FEEDER TRIP & COAL ISSUES
Monroe 3	17-06-14 19:56	17-06-14 20:35	0.65	43	D1	30	800	3836	SUPPLY STEAM FOR UNIT # 3 STARTUP
Monroe 3	13-06-14 9:07	13-06-14 13:49	4.70	75	D1	20	750	267	Air Flow Issues
Monroe 4	13-06-14 13:49	15-06-14 20:00	54.18	76	U1	830	0	1090	Tube Leak
Perry 1	28-06-14 19:10	30-06-14 1:30	30.33	18	D1	34	1209	3149	High ambient temperatures
Pleasants 1	22-06-14 21:34	23-06-14 23:06	25.53	69	D1	260	390	8127	B module O/S -- B Quencher pump ground
Pleasants 1	26-06-14 10:00	26-06-14 10:25	0.42	70	D1	100	550	8410	High SO2 due to 1A ph probe problems
Pleasants 2	11-06-14 3:30	11-06-14 7:21	3.85	30	D1	200	450	8250	2C Modulating Damper Stuck
Pleasants 2	13-07-14 17:28	14-07-14 11:49	18.35	31	D1	84	560	1475	#2 A ID fan Inlet damper not controlling
Summers 6	31-05-14 18:43	03-06-14 11:57	59.95	94	U1	600	0	1000	Tube Leak
Summers 7	06-06-14 10:00	06-06-14 12:16	2.27	96	D1	100	500	3273	Intakes Plugged
Summers 7	01-06-14 8:46	01-06-14 11:40	2.90	69	D1	120	480	270	B Pulv. Tamper. Damper
Summers 8	02-06-14 11:44	04-06-14 8:02	44.30	70	U1	600	0	4261	Steam Leak Rt For. Throttle Vlv.

Client Monitored, Defined, Calculated, Claimed.
A program of Trust; a contract that Pays

	Badger Valley 1	Badger Valley 2	Best	Monroe 1	Monroe 2	Monroe 3	Perry	Pleasant 1	Pleasant 2	Summer 6	Summer 7	Total	Total - Deductivl	AD Hub DA LMP	Hourly
06-11-2014 06:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 30.96	$ 57.79
06-11-2014 07:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 31.86	$ 111.69
06-11-2014 08:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 34.07	$ 244.26
06-11-2014 09:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 36.54	$ 392.67
06-11-2014 10:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 43.04	$ 782.47
06-11-2014 11:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 48.70	$ 1,121.84
06-11-2014 12:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 46.93	$ 1,015.55
06-11-2014 13:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 49.64	$ 1,178.69
06-11-2014 14:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 51.52	$ 1,291.07
06-11-2014 15:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 52.04	$ 1,322.50
06-11-2014 16:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 55.83	$ 1,549.90
06-11-2014 17:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 51.02	$ 1,261.03
06-11-2014 18:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 47.33	$ 1,039.55
06-11-2014 19:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 40.34	$ 620.41
06-11-2014 20:00	0	0	0	0	0	60	0	0	0	600	0	660	60	$ 39.30	$ 557.87
06-12-2014 14:00	0	0	0	0	0	60	0	0	0	0	600	660	60	$ 46.70	$ 1,002.05
06-12-2014 15:00	0	0	0	0	0	60	0	0	0	0	600	660	60	$ 50.40	$ 1,224.23
06-12-2014 16:00	0	0	0	0	0	60	0	0	0	0	600	660	60	$ 50.81	$ 1,248.40
06-12-2014 17:00	0	0	0	0	0	60	0	0	0	0	600	660	60	$ 43.67	$ 820.03
06-12-2014 18:00	0	0	0	0	0	60	0	0	0	0	600	660	60	$ 45.79	$ 947.14
06-12-2014 19:00	0	0	0	0	0	60	0	0	0	0	600	660	60	$ 41.40	$ 683.93
06-12-2014 20:00	0	0	0	0	0	60	0	0	0	0	600	660	60	$ 39.41	$ 564.73
06-12-2014 21:00	0	0	0	0	0	60	0	0	0	0	600	660	60	$ 38.82	$ 528.90
06-15-2014 14:00	0	0	0	0	0	830	0	0	0	0	600	1430	830	$ 34.17	$ 3,458.82
06-15-2014 15:00	0	0	0	0	0	830	0	0	0	0	600	1430	830	$ 37.05	$ 5,851.36
06-15-2014 16:00	0	0	0	0	0	830	0	0	0	0	600	1430	830	$ 37.04	$ 5,845.14
06-15-2014 17:00	0	0	0	0	0	830	0	0	0	0	600	1430	830	$ 41.14	$ 9,244.66
06-15-2014 18:00	0	0	0	0	0	830	0	0	0	0	600	1430	830	$ 38.50	$ 7,057.62
06-15-2014 19:00	0	0	0	0	0	830	0	0	0	0	600	1430	830	$ 37.85	$ 6,516.81

Thank you

Legal notice