UNIVERSITY OF PIRAEUS
Department of International & European Studies
MSc in Energy: Strategy, Law and Economics

Special Issues in energy finance & risk management

"Weather Derivatives"

Sat, 28 nov 2020

Weather Risk Management
in the Energy Sector

Exposure to Weather Conditions

The energy sector is perceived as one of the most exposed to Weather Conditions sectors. There are Direct and Indirect consequences:

Direct

- Damages of Infrastructures
- Power Plants
- Transmission Lines

Indirect

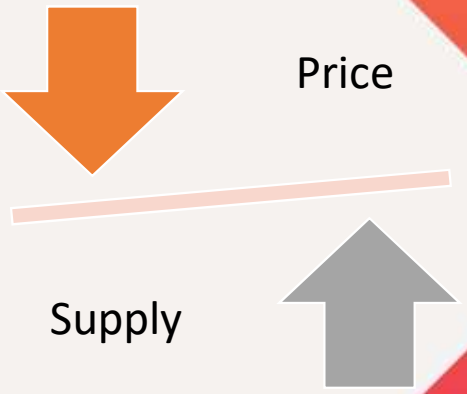
- Supply / Demand Balance
- Production of Wind / PV / Hydro
- Scarcity of Hydro → affects hydro price

Some facts

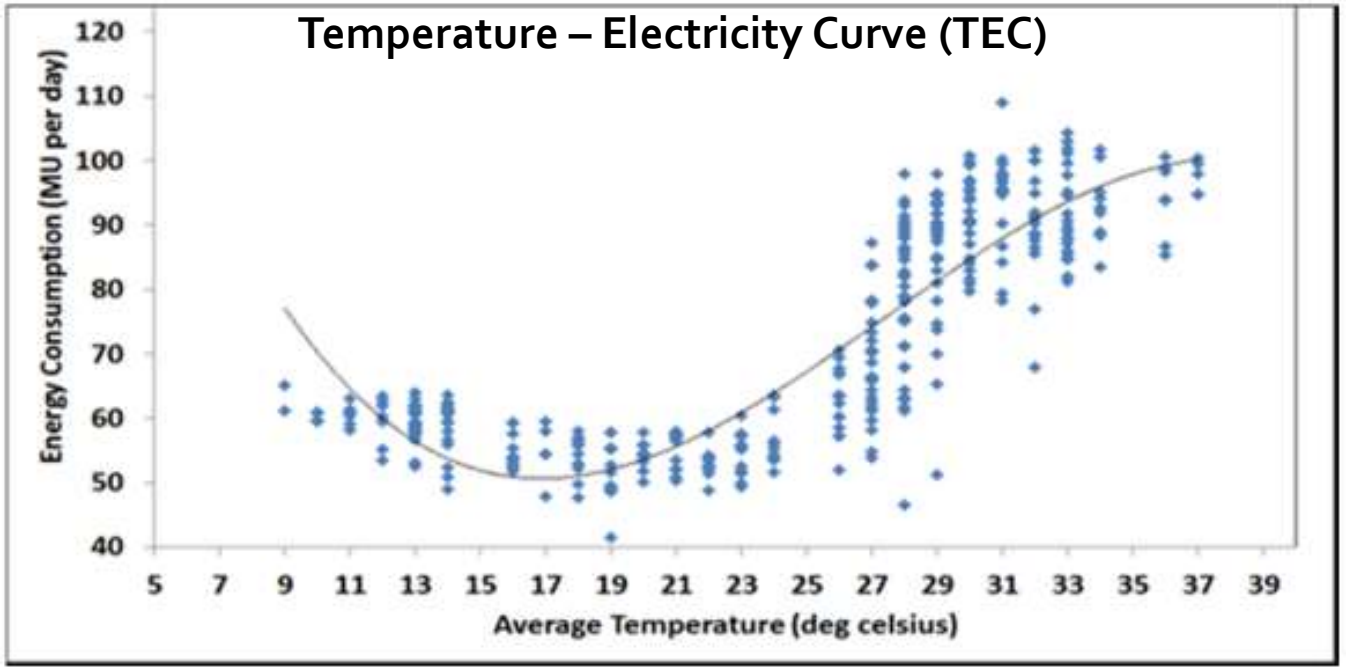
- 1.5 ◦C average surface temperatures on Earth increase since the end of the 19th century
- 2016 and 2017 were ranked respectively as a first and second warmest years since 1880
- average Earth temperature is observed recently sped up to 0.13 ◦C per 10 years
- Oceanic currents are an important factor driving the climate of many countries
- extreme weather anomalies emerge by:
  - high vulnerability of rainfall
  - the changing structure of rainfall (draught followed by 2–3 intensive rainfalls, leading to floods)
  - incidents of hail, and
  - a sharp increase or decrease in temperature
- hotter springtime,
- "Saharan" heat waves in summer and
- warmer and much shorter winters

Direct Weather Consequences

- Late 2010 to early 2011 coal mines in Queensland in Australia were severely disrupted by heavy rain and floods due to La Niña event
- Oil and Gas industries are exposed to losses due to the devastating impact of hurricanes and storms, and in this case, hurricane Katrina in 2005 remains the costliest natural disaster (with high losses due to oil spills in Louisiana).
- Heatwaves are an example of a potentially dangerous weather-related risk for nuclear power plants, as it may cause ineffective cooling with water (when water temperatures are too high or water flows are too low), as observed in France in 2003
- In Poland in example the excessive snowfalls, followed by frost wave, that occurred at the beginning of April 2008 in Szczecin (one of the largest Polish agglomerations) and its surroundings. These unusual (as for April) and extreme weather conditions caused a serious blackout, due to the destroyed power transmission infrastructure



Indirect Weather Consequences



Some studies examine the relationship between the TEC and other factors of socio-economic development, such as:

- the level of income
- the extent of electrification
- the energy efficiency improvements
- the cultural habits

Indirect Weather Consequences

The **underestimation** or **overestimation** of energy demand may in turn affect energy prices (as a consequence of the changes to the energy supply–demand equilibrium).

In this context, the changing weather conditions may severely affect the energy market equilibrium, as weather conditions remain related to the observation of long-term changes of temperatures, as well as extreme weather events related to heat or frost waves (in unusual seasons).

Risk Identification

The possible risk management strategies embrace:

1. risk avoidance (do not involve in risky activities)
2. risk reduction (methods that help to prevent the risk occurrence or reduce its impact if already occurred)
3. risk financing (the methods that allow to prepare the stream of funds that help to restore in the aftermath of risk) → e.g. weather derivatives

The selection of the adequate strategy (or mix of these strategies) should be preceded by the identification of risk, which means the identification of the particular threats and the measurement of their potential impact **(severity)** and likelihood **(chance)** of occurrence.

Insurance hedging of weather risk

The main drawback of weather insurance is that it is rational only for the weather risk exposures that distinguish with **low frequency and high severity**, which is a feature of extreme weather conditions (such as hail, storms, or draughts).

Insurance cannot be implemented for weather exposures that distinguish with high frequency and low severity.

Thus, insurance is not suitable for the management of weather risk related to the impact of changing weather conditions on heating and cooling demands, which is the prime weather risk exposure in the energy sector.

However, this kind of weather risk exposure could be hedged with the application of **weather derivatives**.

Weather Derivatives definition

Weather derivative is defined as a financial instrument whose pay-out is contingent on weather conditions (meteorological events).

More specifically, the underlying in weather derivatives are indices related to changing weather conditions

WEATHER AND HURRICANE FUTURES & OPTIONS

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PRELIMINARY

WEATHER INDEX FUTURES

	GLOBEX OPEN	GLOBEX HIGH	GLOBEX LOW	SETT. & PT.	PRICE CHGE	VOLUME TRADES CLEARED	OPEN INTEREST		--CONTRACT-- HIGH	LOW
HDD CHICAGO F										
FEB21	----	----	----	1051.0	+ UNCH	----	150	UNCH	----	----
JAN21	----	----	----	1241.0	+ UNCH	----	150	UNCH	----	----
DEC20	----	----	----	1030.0	+ UNCH	----	1600	UNCH	----	----
NOV20	----	----	----	565.0	+ UNCH	----	1200	UNCH	----	555.0A
TOTAL HDD CHICAGO F						0	3100			

Temperature Derivatives (1/2)

The weather index

- Heating Degree Days (HDD)
- Cooling Degree Days (CDD)

is one of the basic elements of weather derivatives. It express the difference between a reference level of temperature and the average daily temperature.

However, there are several other relevant elements:

1. the accumulation period or the period of time over which the index accumulates *(usually a month or a season)*
2. the location of the weather station that reports daily temperatures for a particular region *(usually the station is located in a major city)*
3. the so called "tick size" which is the dollar amount attached to each HDD or CDD, this is the amount to be paid per unit of the CDD or HDD

Temperature Derivatives (2/2)

A reference level of temperature is assumed at

- 65 ◦F in the US and
- 18 ◦C elsewhere,

which is the level of indoor temperature presumed to be comfortable by the utility industry.
Accordingly, higher HDD is a consequence of colder temperatures and signalizes higher demand for heating: **HDD = max (18 ◦C –T, 0)**

where T means the average daily temperature.

Higher CDD is a consequence of warmer temperatures and the higher demand for cooling: **CDD = max (0, T –18 ◦C)**

The average daily temperature (T) is measured as the arithmetic average of the daily maximum and minimum temperatures.

Other Weather Derivatives

Other weather-dependent indices are also traded, like:

- precipitation (rainfall and snowfall)
- Humidity
- sunshine

Brief history:

In the US, the CME (Chicago Mercantile Exchange) has quoted weather derivatives since 1999.
In Europe, the LIFFE (London International Financial Futures and Options Exchange, now part of Euronext) initiated the trade of weather derivatives in 2000, for mean monthly temperatures in Berlin, Paris, and London.
The weather derivatives market was growing rapidly until Enron collapsed in 2002, which led to a loss of confidence in derivative transactions.
The market recovered after a few years, with growing transaction volumes.


We are.

We are.

An experienced team of Energy and IT experts operate under E-ntelligence ltd umbrella since 2013.

<u>The founder & Owner:</u>

- ***Ioannis Psarros**, Power Trader since 2008*

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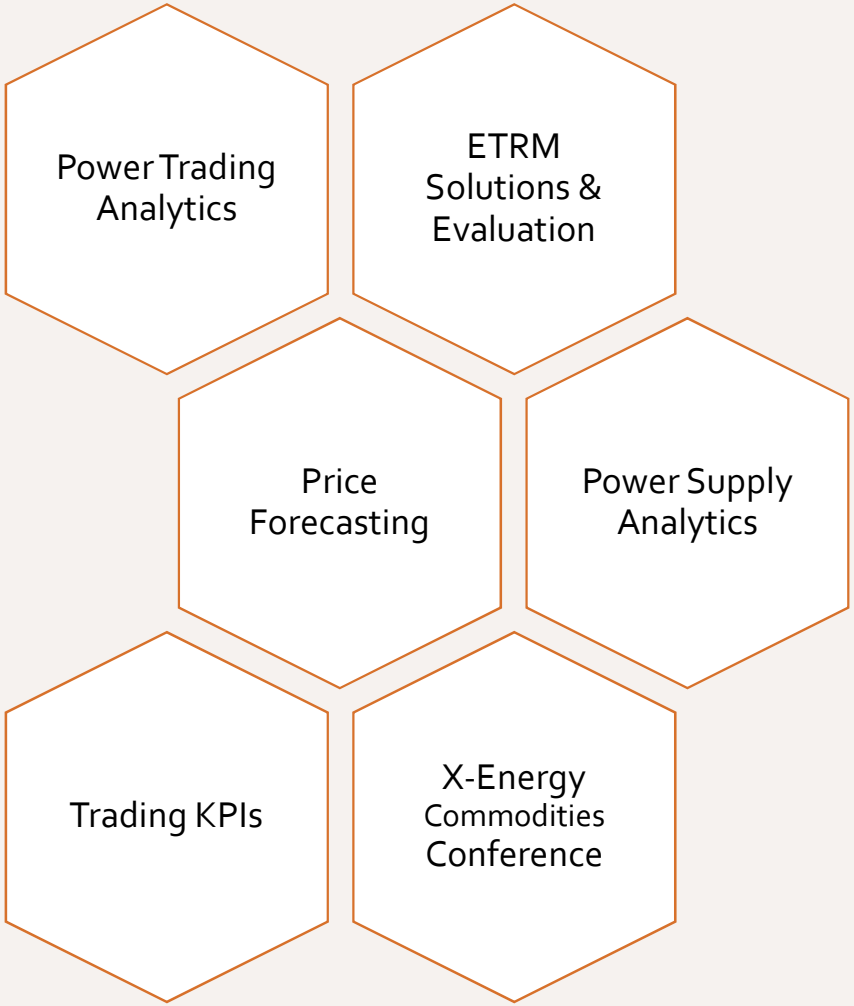
We do.

We do.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Thank you!

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