

# Electricity Derivatives

Paul Stefiszyn

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# About ESP Consulting

## Our offices



- ESP Consulting UK
- ESP Consulting Benelux
- ESP Consulting Nordics

## Our services

We provide consultancy services to energy companies, utilities, governments and regulators, covering:

- Energy Trading & Risk Management
- Wholesale Market Policy & Reform
- Market Strategy & Organisational Improvement
- Networks Regulation
- Wind Development

## Some recent clients



# Paul Stefiszyn

## Paul Stefiszyn Director, ESP Consulting Benelux



- Expert in commodity risk management with over a decade of experience in risk modelling, valuation, and risk control.
- Advises industrial and trading clients on the practical implementation of best-practice risk management:
  - policy development;
  - specification of risk reporting;
  - implementation of risk models;
  - design of the Risk Management organisation and capacity building;
  - trading and risk system requirements; and
  - business process design and optimisation.
- Before joining ESP Consulting Paul held several senior Risk Management roles at Nuon Energy, a vertically integrated energy utility and trading operation.

# Introductions ...

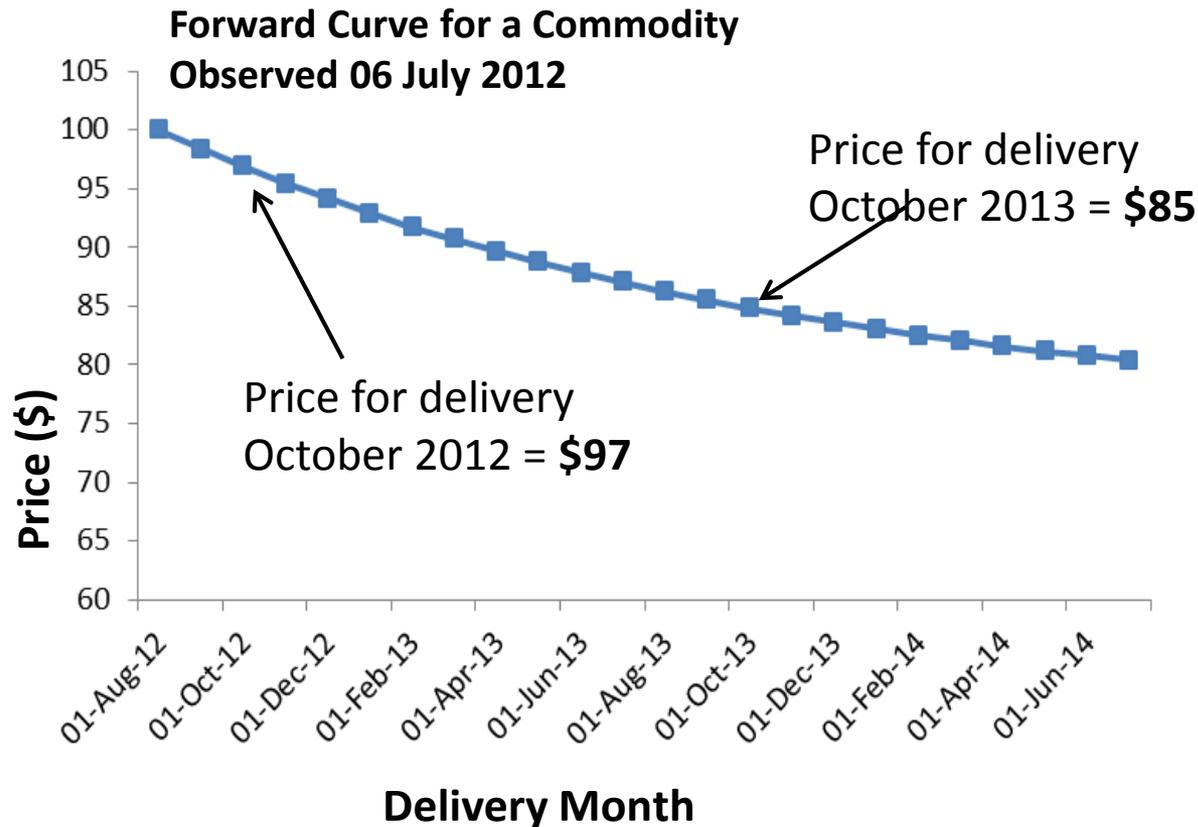
- What do you expect to learn ?
- What do you want to learn (if different than answer to question 1)?
- What have you already learned in the first part of this tour?

# Spot and Forward Prices

- Spot price – price payable immediately for power for immediate delivery
- Forward price – price agreed now, payable in the future for power delivered at a specific time in the future
- Some precisions
  - Settlement
  - Spot power: day-ahead, hourly, intraday, balancing, imbalance

# Forward Curve

- The set of forward prices for all future delivery periods is called the forward curve



# Forward Contracts

- A power forward contract is an agreement between two **counterparties** for the delivery of electricity at a certain time in the future for a certain price that is agreed and fixed at the start of the contract.
- Forward contracts can be customized to accommodate any volume and any forward delivery period (as well as e.g. delivery point, etc.) but often have standard features
- Example: power forward contract
  - **Counterparties:** Vattenfall (Buyer) and EdF (Seller)
  - **Asset/Commodity:** Dutch power baseload (Tennet)
  - **Delivery:** 00:00 01 December 2014 to 23:59 31 December 2014
  - **Settlement:** EFET terms (20 days after final delivery)
  - **Priced Fixed:** € 50 per MWh
  - **Trading Volume:** 5 MW (3720 MWh)

# Forward Contracts on Electricity and Gas

- Discrete delivery: oil (by boat or barge), coal, LNG
- “Flow commodities”: electricity, natural gas, pipeline oil
- Electricity and natural gas are delivered over time: there is a start and end point
- Often the forward contract specifies delivery over a quarter (3 months), a season (6 months), or a calendar (1 year)
- Normally monthly settlements, i.e. pay monthly (12 payments for a calendar contract)
- Possible to specify different prices for different sub-periods (e.g. stepped price contract)

# Mark to Market

- “Mark to market” is a calculation to find the new value of an asset or commodity position, taking into account the latest price of the underlying product
- It is best explained by an example:

## Example 1

- I have a contract to receive 3720 MWh of power from a counterparty in return for payment of €50/ MWh.
- The nominal value of the contract (i.e. the amount I will pay at settlement) is € 186 000
- Suppose the current price of power is € 52/ MWh.
- The mark to market of the position is  $3720 * (\text{€ } 52 - \text{€ } 50) = \text{€ } 7440$

# Long and Short Positions

- In trading, we say that positions or exposures are “long” or “short”
- We are long if we own or are buying an asset or commodity. We benefit if the price is rising
- We are short if we are selling an asset, or have an obligation to deliver. We benefit if the price is falling. Normally, a short position has a negative volume.

## Example 1

- I have a contract to **receive** 3720 MWh of power from a counterparty in return for payment of €50/ MWh. Suppose the current price of power is € 52/ MWh.
- The mark to market of the position is  $3720 * (\text{€ } 52 - \text{€ } 50) = \text{€ } 7440$

## Example 2

- I have a contract to **deliver** 3720 MWh of power from a counterparty in return for payment of €50/ MWh. Suppose the current price of power is € 52/ MWh.
- The mark to market of the position is  $3720 * (\text{€ } 50 - \text{€ } 52) = \text{€ } - 7440$

# Profit and Loss

- The change in mark to market of a portfolio is normally called the **Profit and Loss** or **P&L**.
- P&L is normally associated with a period of time, such as the **1-day P&L** (change in mark to market of the portfolio since yesterday) or the **year-to-date P&L** (change in mark to market of the portfolio since 01 January).
- If a commodity is delivered (and cash received), then we call the P&L a **realised P&L**
- We can open and close a commodity exposure in the forward market without taking delivery of the commodity. In this case we have an **unrealised P&L** until the cashflows are exchanged.

# Future Contracts

- Futures contracts are highly uniform and well-specified commitments for a carefully described commodity (quantity and location) to be delivered at a certain time and place (acceptable delivery date and location) and in a certain manner (method for closing the contract).

	<b>Forward</b>	<b>Futures</b>
Trade on organized exchanges	No	Yes
Use standardised contract terms	No	Yes
Use clearing to guarantee contract fulfillment	No	Yes
Require margin payments and daily settlements	No	Yes

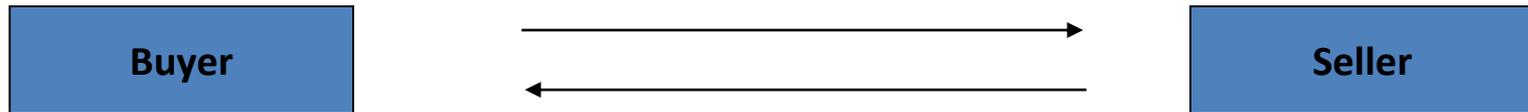
- More and more frequently, OTC futures also use standard contract terms (master trading agreements) and are cleared (counterparties agree to “give up” contracts to a clearing house).

# Clearing House

- A **Clearing House** (or **Central Clearing Counterparty**) is an agency associated with an exchange, which settles trades and regulates delivery. Each exchange uses a futures clearing house. Clearing houses may be part of a futures exchange, or a separate entity.
- Clearing houses guarantee the obligations of futures contracts by all parties involved, mitigating the credit risk of the transaction. Both the buyer and the seller have obligations only to the clearing house, and not to each other.
- Clearing houses are “perfectly hedged” by maintaining no futures market position of their own.

# Clearing House

Obligations without a clearinghouse:



Obligations with a clearinghouse:

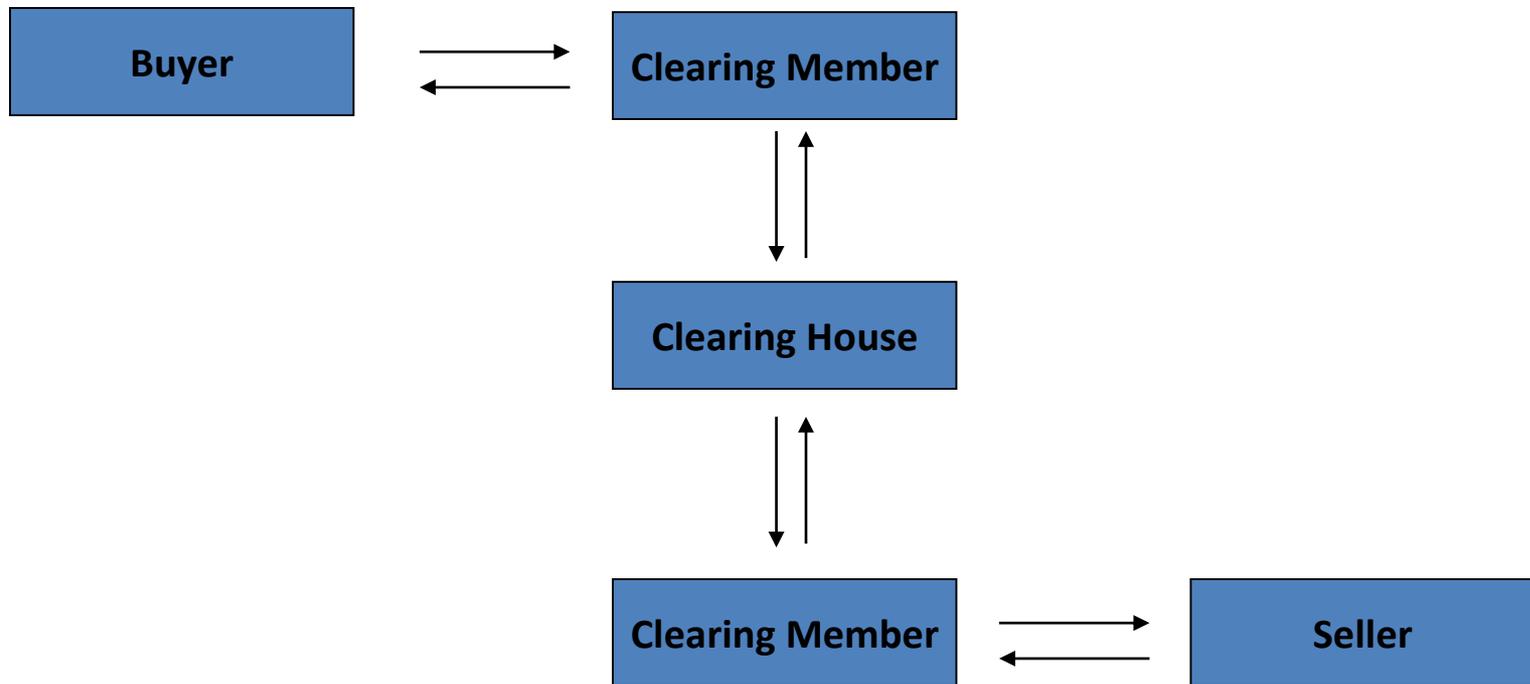


# Clearing Member

A **Clearing Member** (or **Clearing Bank**) is a highly capitalised and closely monitored company that guarantee all trades made on an exchange and/or cleared by a clearing house. A clearing member must have privileges of clearing membership on an Exchange in order to clear that Exchange's products.

Clearing members assume full financial and performance responsibility to the clearing house for all transactions executed through them. Clearing members are responsible and accountable for every position they carry, whether it is for the account of a non-member customer, or its own proprietary account.

# Cash Flows with a Clearing Member



# Margin and Daily Settlement

- **Margin** is a deposit (normally cash, can also be a bank guarantee or other collateral) made by buyer or seller of a futures contract to the clearing member (or by the clearing member to the clearing house).
- Types of margin include:
  1. **Initial Margin:** Deposit that a buyer or seller must make to their margin account at the time of trading a futures contract.
  2. **Variation Margin:** Additional margin (e.g. cash deposit) required to bring a margin account up to the required level.
- **Daily Settlement** (or “margining”) is a process by which buyers or sellers of futures are required to realise any losses or gains in cash immediately (“mark-to-market”), based on the daily **settlement price** (price of futures contracts at the end of the trading day). The losses are deducted from the margin deposit.

# Example of Daily Settlement

## Day 0

- Suppose a firm purchases a single contract (5 MW) for Dutch baseload power December delivery at a price of € 50 at the close of day 0.
  - If the firm were to receive delivery of power at this price, the total value of the contract would be  $5 \text{ MW} * 24 * 31 \text{ hours} * € 50 = € 186 000$  .
- Suppose further the clearing house requires an initial margin of € 8200 (calculated based on an internal algorithm of the clearing house).
- Firm therefore transfers € 8200 to the margin account at their clearing bank (who is a clearing member of the clearing house).

# Example of Daily Settlement (continued)

## Day 1

- Suppose that December power closes at € 49.50 / MWh at the end of day 1.
- Loss is therefore € 0.50/ MWh or € 1860 /contract.
- Firm moves an additional € 1860 to the margin account at the clearing bank.

## Day 2

- Suppose that December power closes at € 50.50 / MWh at the end of day 2.
- Gain is therefore € 1.00/ MWh or € 3720 /contract.
- Firm may transfer € 3720 from the margin account at the clearing bank back to their current account.

# Closing a Futures Position

- Some common ways to close a futures contract include:
  - **Delivery:** Most commodity futures allow for settlement of the futures contract through the physical delivery of the particular good. Possibilities regarding the quality of the commodity, delivery locations, and timing, are specified in the contract.
  - **Cash Settlement:** Most futures contracts allow completion through cash settlement. In cash settlement, buyers and sellers make payments at the expiration of the contract to settle any gains or losses, instead of making physical delivery.
  - **Offset or Reversing Trade:** If you previously sold a futures contract, you can close out your position by purchasing an identical futures contract. The exchange will cancel out your two positions.

## Definition of Commodity Price Risk

***“ Commodity price risk is the variability of the firm’s financial results resulting from changes in the market prices of commodities. ”***

# Long and Short Exposures

- A market price risk is said to be a “**long** exposure” if the position **benefits from increasing prices** (and is harmed by decreasing prices)
- A market price risk is said to be a “**short** exposure” if the position **benefits from decreasing prices** (and is harmed by increasing prices)
- Quiz: Long or short? Which commodities?
  - Coal mining company?
  - Airline?
  - Power generator (using coal to produce electricity)?
  - Oil refiner?
  - Natural gas importer/ distributor?

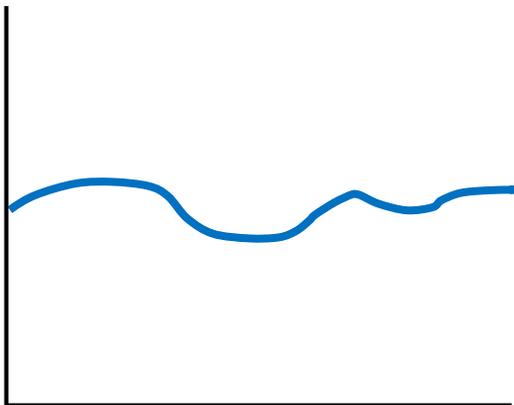
# Hedging of Commodity Price Risk

- It is possible to proactively manage and reduce a commodity price risk exposure by **hedging**.
  - We assume here that this risk is not desired, e.g. the shareholders are not investing in the firm in order to gain the commodity exposure.
- Hedging is the process of using commodity derivative instruments (e.g. forwards, futures, and swaps) to reduce or eliminate a pre-existing market price risk.
- Firms that have a long exposure can hedge their risk by selling a derivative contract. Firms that have a short exposure can hedge their risk by buying a derivative contract.

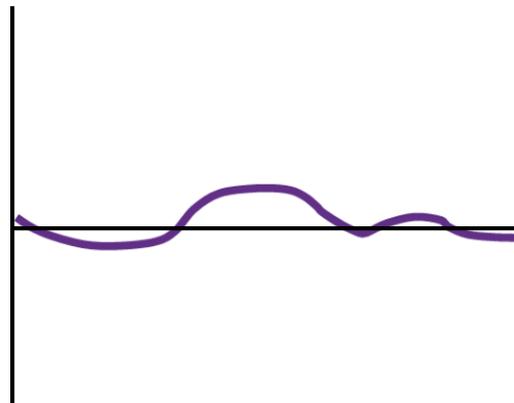
# Using Derivatives to Hedge an Exposure

- A financial derivative can be used to offset the risk of a physical commodity risk exposure

A company has risk exposures resulting from its business



... but an appropriate commodity derivative will provide offsetting financial cashflows ...



... effectively fixing the price of the commodity for the company



# Indexed (Floating-Price) Contracts

- In the previous examples, the price to be paid for the commodity is defined in the contract.
- In contrast, a floating price contract leaves the exact amount of the price unspecified, but states how the amount to be paid will be determined, usually by referencing the price of the commodity observed on a future date.
- Many floating price contracts reference a price index rather than an actual commodity that can be delivered.
- Example: the API#2 price index is the benchmark price reference for coal imported into northwest Europe.
  - It is calculated as an average of the Argus cif ARA assessment and McCloskey's northwest European steam coal marker.
  - The Argus and McCloskey assessments are based on surveys of traders of the price of certain qualities of coal delivered into Europe, as well the actual price of deals actually executed.

# Swaps

- A swap is a financially-settled contract. There is no delivery of the commodity.
- The most common swap is a fixed for floating swap
  - Long a swap: pay an agreed fix price, to receive a floating price
  - Short a swap: pay a floating price to receive an agreed fixed price
  - Example: long an August 2012 API#2 coal swap for 1000 tonnes at \$100

# Options Definition

- An option is a contract which gives the holder the **right**, but **not the obligation**, to enter into a transaction [buy or sell a commodity] at a pre-agreed price, quantity, time [by a specified date in the future], and terms.
- The option buyer pays the seller an upfront fee (the premium) for the option rights.
- Basic Options Structures
  - **Call options:** Holder (buyer) of the option has the **right to buy**, and writer (seller) of the option has the **obligation to sell**, underlying commodity at agreed price and time
  - **Put options:** Holder (buyer) of the option has the **right to sell**, and writer (seller) of the option has the **obligation to buy**, underlying commodity at agreed price and time

# Basic Dimensions of Options

- Buy (hold = long) or Sell (write = short)
- Call or Put
- Underlying asset
  - Commodity, Instrument
  - Quantity
- Strike (exercise) price
- Maturity
- Premium
- Implied volatility

# Strike Price of an Option

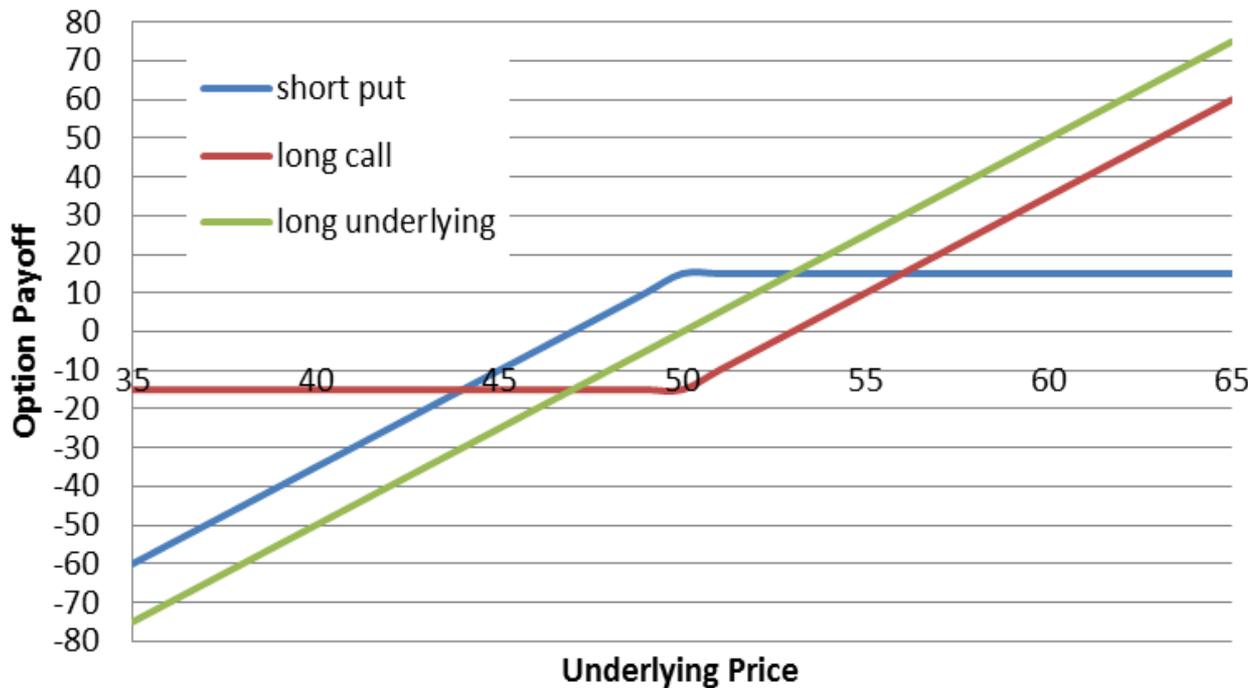
- **Strike Price** – Fixed price to be paid if option exercised, as specified in the options agreement
- Example: I hold a call option on 1000 tonnes of coal with strike \$100/ tonne
  - I am the buyer of an option, which gives me the right to buy 1000 tonnes of coal (if I choose) for \$100/ tonne from the seller of the option.
  - \$100 is the **strike price**
  - I will **exercise** the option (i.e. buy the coal, paying \$100 to the seller) only if the market price of coal at the time is above \$100. If the market price is below \$100, then I will not exercise the option, but rather buy coal in the market.
- Example: I hold a put option on 1000 tonnes of coal with strike \$90/ tonne
  - I am the buyer of an option, which gives me the right to sell 1000 tonnes of coal (if I choose ) for \$90/ tonne to the seller of the option
  - When will I exercise this option?

# Option Premium

- **Premium** – Price of the option that buyer pays and seller receives at the time of option transaction
- Example: I hold a call option on 1000 tonnes of coal with strike \$100/ tonne. For this option I paid \$4/ tonne, or \$4000 total.
  - I pay \$4/ tonne at the beginning of the contract. \$4 is the **premium**.
  - If I exercise the option, I will pay a further \$100/ tonne on delivery of the coal.
  - If I do not exercise the option (i.e. if the option **expires**), then I do not get my \$4 back !

# Returns On Basic Options

## Payoff Functions



What is the strike price of the call and the put?

What is the quantity of underlying for these options ?

What was the premium paid for the call and received for the put ?

# Factors Determining the Price of an Option

- Moneyness of the option (i.e. ratio of the price of the underlying to the strike price)
  - Future volatility of the underlying price, from now until maturity of the option
  - Duration of the option, i.e. time to maturity
  - Shape of the forward curve (i.e. contango/ backwardation), for options on spot
  - Interest rates
- 
- Note that all of these factors are observable, with the exception of the future volatility of the price of the underlying