# Power generation assets valuation adopting a real options approach applied to the Colombian electricity market

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Oral progress report

April 8th, 2015

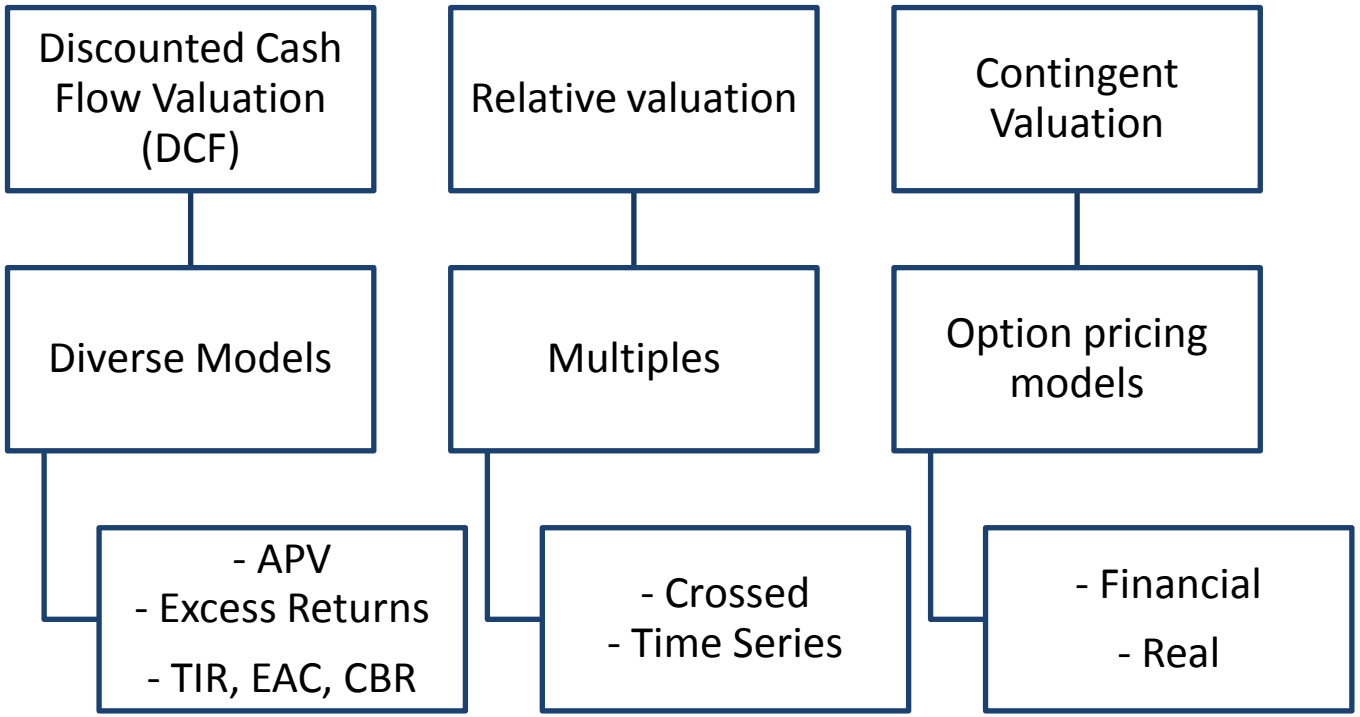
“Valuation is not an objective exercise, and any preconceptions and biases that an analyst brings to the process will find their way into the value. And even the very best valuation will yield an estimate of the value, with a substantial likelihood of you being wrong in your assessment.”

**- Domodaran**

# Problem definition

- Power generation sector develops in a highly uncertain and competitive environment where private investment is the main driver of expansion.
- Discounted cash flow valuation is the conventional technique used for power generation assets valuation.
- The Classic DFC method is inappropriate to value this kind of assets due to high uncertainty of the sector and its lack of capability to assign value to possible particular competitive advantages beach asset.
- This project pretends to pose an alternative methodology to valuate power generation assets in the Colombian market

# Asset Valuation



# Advantages

**DCF Valuation**

- Simple and replicable application method.
- Intrinsic valuation.
- Ease of understanding
- Widely used, considered the fundamental base of the other methodologies.

**Relative Valuation**

- Intuitive method, used in a daily, unconscious manner.
- Useful and simple method applied easily to different cases.
- The development of multiples offer relevant information that can be useful.

**Contingent Valuation**

- Flexible method
- Takes into account the uncertainty associated to the asset properties.
- Accurate reality modeling
- Valuates the optionality present in the assets or in possible strategic decisions

# Disadvantages

**DCF Valuation**

- Rigid method
- Requires a priori knowledge of the future expected cash flows
- Difficulty to incorporate risk and uncertainty to the valuation
- High sensitive parameters

**Relative Valuation**

- Ignores available information
- Time static valuation.
- Requires an assets with similar characteristics
- Supposes the correct market valuation of similar assets

**Contingent Valuation**

- Complex method
- Difficulty to define the necessary parameters for real assets valuation
- Non-replicable (easily) method
- Due to an incorrect problem definition it may cause possible systematic errors in the valuation

# Power generation assets flexibilities

- Operational flexibilities
  - Frequency control
  - Quick operating ramp (Peaking capacity)
- Commercial flexibilities
  - Contract level
- Investment flexibilities
  - “Wait to invest”
  - Installed capacity decision
  - Possible expansion opportunity

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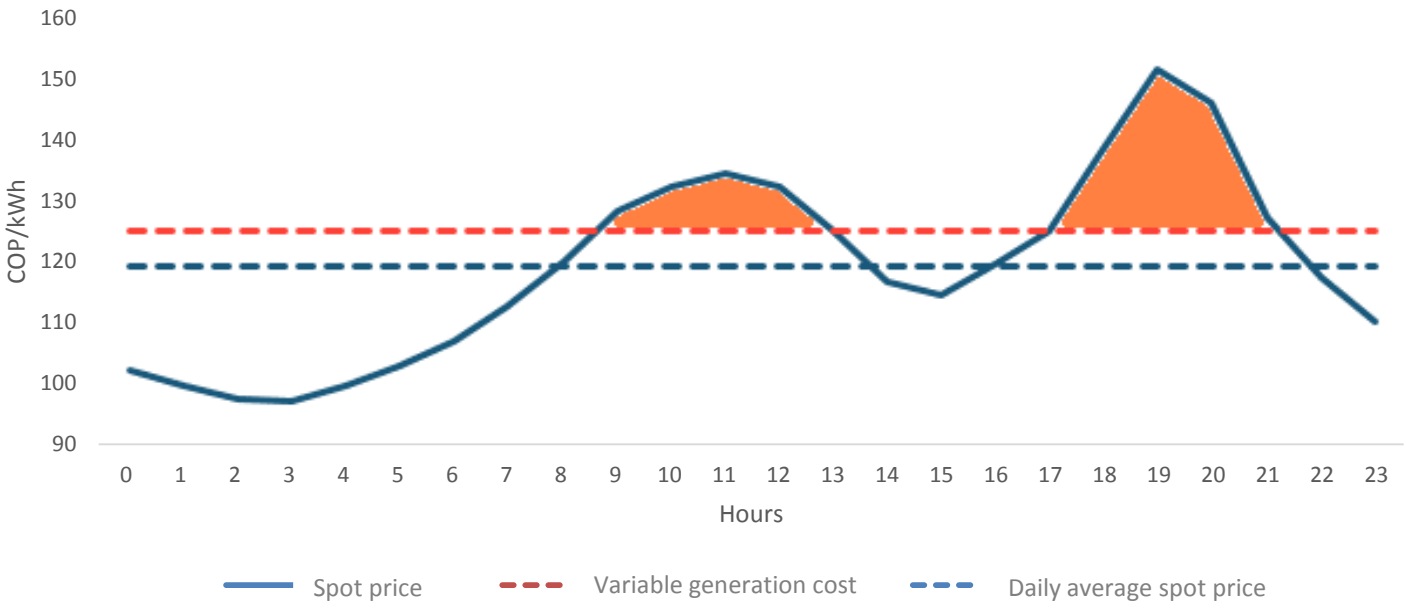
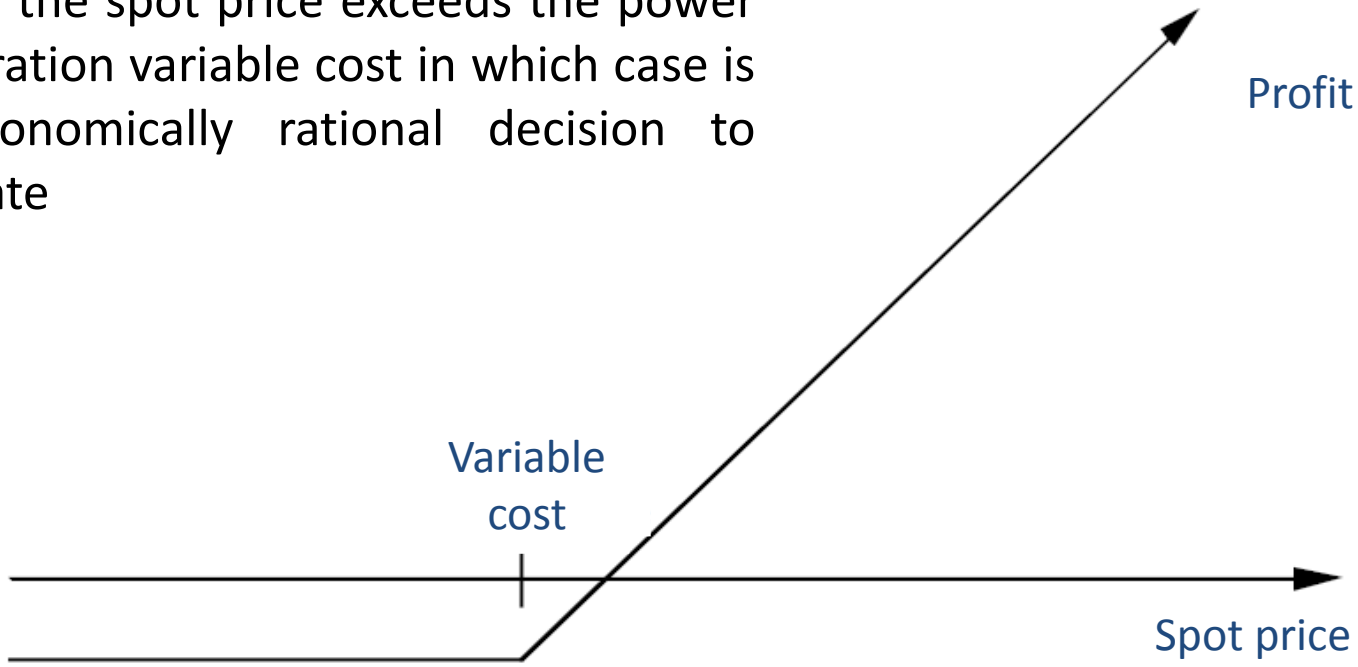
# Operational flexibility




The technology used in a power generation project can offer significant operational advantages over other plants. On this depends on the ability to optimally capture intraday peaks of energy prices.

# Real options approach

The contingent cash flow takes place when the spot price exceeds the power generation variable cost in which case is a economically rational decision to operate



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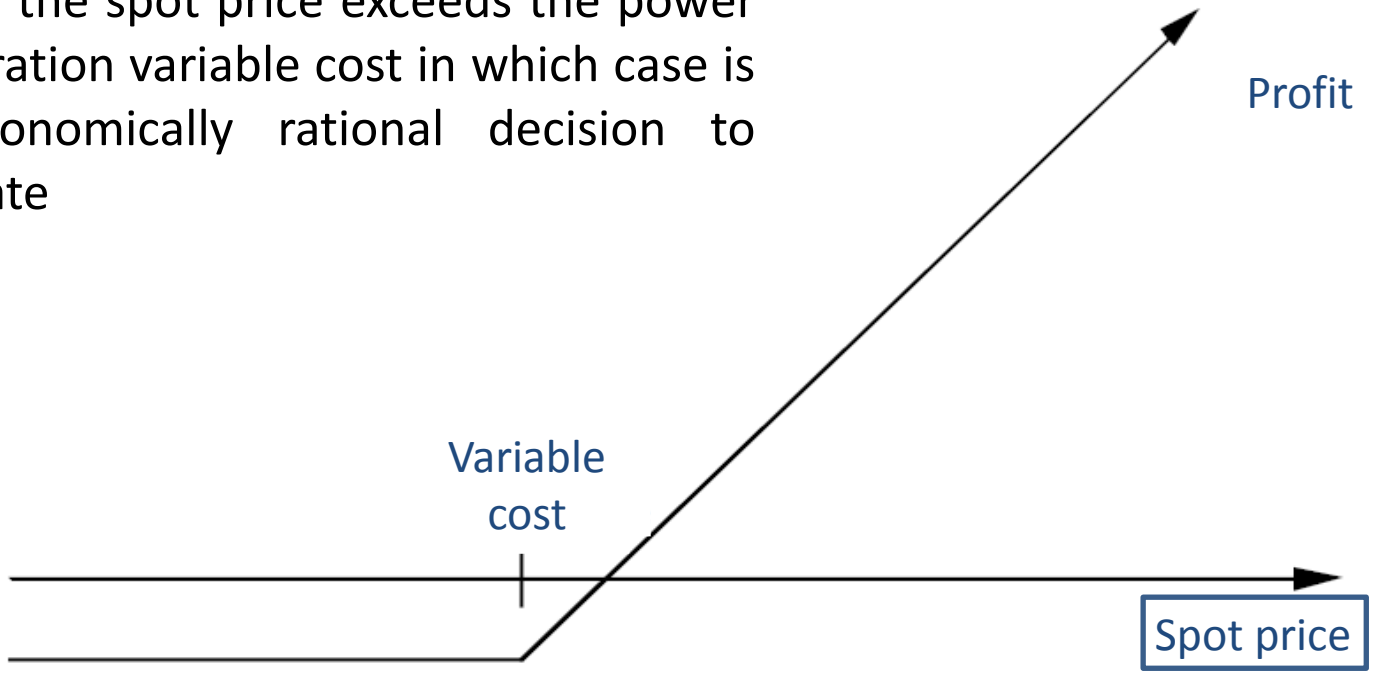
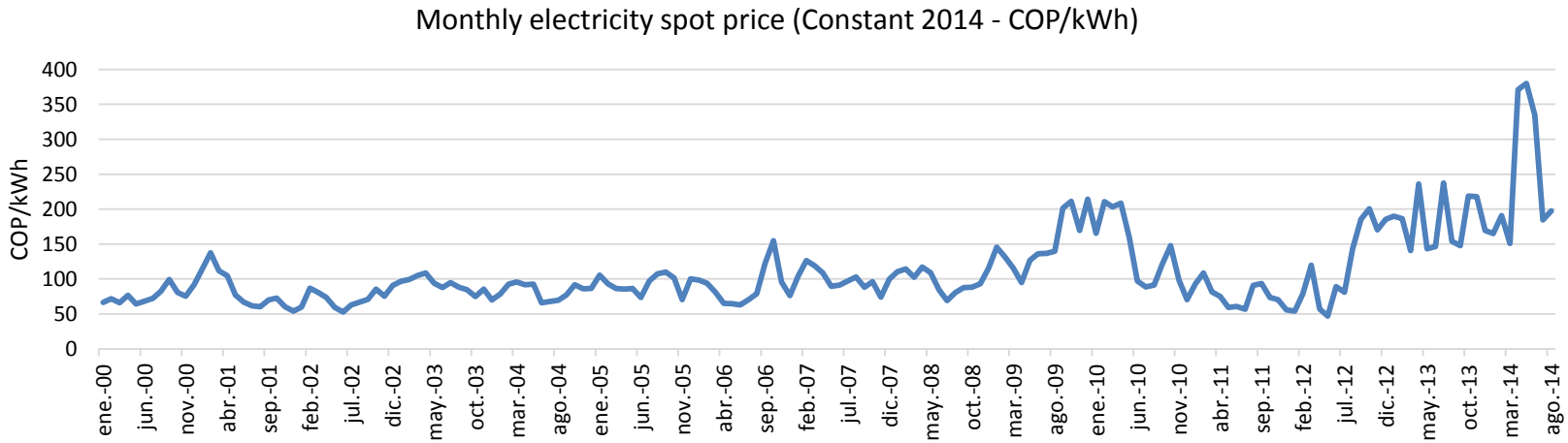
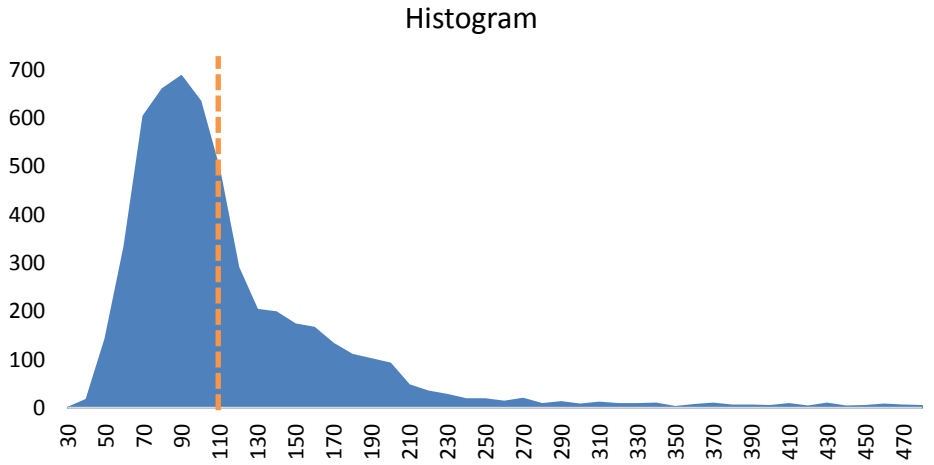


# Spot price




The spot price fluctuates in a wide range of values. It can be inferred that the spot price is a highly volatile signal.



# Variance analysis

| | Jan. | Feb. | Mar. | Apr. | May. | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **January** | 1,00 | 0,00 | 0,05 | 0,00 | 0,03 | 0,00 | 0,00 | 0,05 | 0,05 | 0,00 | 0,00 | 0,00 |
| **February** | 0,00 | 1,00 | 0,03 | 0,00 | 0,05 | 0,00 | 0,90 | 0,04 | 0,04 | 0,01 | 0,12 | 0,36 |
| **March** | 0,05 | 0,03 | 1,00 | 0,00 | 0,84 | 0,00 | 0,02 | 0,98 | 0,98 | 0,00 | 0,00 | 0,00 |
| **April** | 0,00 | 0,00 | 0,00 | 1,00 | 0,00 | 0,60 | 0,00 | 0,00 | 0,00 | 0,19 | 0,02 | 0,00 |
| **May** | 0,03 | 0,05 | 0,84 | 0,00 | 1,00 | 0,00 | 0,03 | 0,87 | 0,86 | 0,00 | 0,00 | 0,00 |
| **June** | 0,00 | 0,00 | 0,00 | 0,60 | 0,00 | 1,00 | 0,00 | 0,00 | 0,00 | 0,42 | 0,08 | 0,01 |
| **July** | 0,00 | 0,90 | 0,02 | 0,00 | 0,03 | 0,00 | 1,00 | 0,02 | 0,03 | 0,01 | 0,14 | 0,42 |
| **August** | 0,05 | 0,04 | 0,98 | 0,00 | 0,87 | 0,00 | 0,02 | 1,00 | 0,99 | 0,00 | 0,00 | 0,00 |
| **September** | 0,05 | 0,04 | 0,98 | 0,00 | 0,86 | 0,00 | 0,03 | 0,99 | 1,00 | 0,00 | 0,00 | 0,00 |
| **October** | 0,00 | 0,01 | 0,00 | 0,19 | 0,00 | 0,42 | 0,01 | 0,00 | 0,00 | 1,00 | 0,34 | 0,10 |
| **November** | 0,00 | 0,12 | 0,00 | 0,02 | 0,00 | 0,08 | 0,14 | 0,00 | 0,00 | 0,34 | 1,00 | 0,50 |
| **December** | 0,00 | 0,36 | 0,00 | 0,00 | 0,00 | 0,01 | 0,42 | 0,00 | 0,00 | 0,10 | 0,50 | 1,00 |

A two sample F-test is done to determine if the volatility between months is statistically equal

# Variance analysis

| | Jan. | Feb. | Mar. | Apr. | May. | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **January** | 0 | 0 | **1** | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 |
| **February** | 0 | 0 | 0 | 0 | **1** | 0 | **1** | 0 | 0 | 0 | **1** | **1** |
| **March** | **1** | 0 | 0 | 0 | **1** | 0 | 0 | **1** | **1** | 0 | 0 | 0 |
| **April** | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 | **1** | 0 | 0 |
| **May** | 0 | **1** | **1** | 0 | 0 | 0 | 0 | **1** | **1** | 0 | 0 | 0 |
| **June** | 0 | 0 | 0 | **1** | 0 | 0 | 0 | 0 | 0 | **1** | **1** | 0 |
| **July** | 0 | **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | **1** |
| **August** | 0 | 0 | **1** | 0 | **1** | 0 | 0 | 0 | **1** | 0 | 0 | 0 |
| **September** | **1** | 0 | **1** | 0 | **1** | 0 | 0 | **1** | 0 | 0 | 0 | 0 |
| **October** | 0 | 0 | 0 | **1** | 0 | **1** | 0 | 0 | 0 | 0 | **1** | **1** |
| **November** | 0 | **1** | 0 | 0 | 0 | **1** | **1** | 0 | 0 | **1** | 0 | **1** |
| **December** | 0 | **1** | 0 | 0 | 0 | 0 | **1** | 0 | 0 | **1** | **1** | 0 |

There is not a clear definition of clusters or groups of months with the same behavior in terms of volatility.

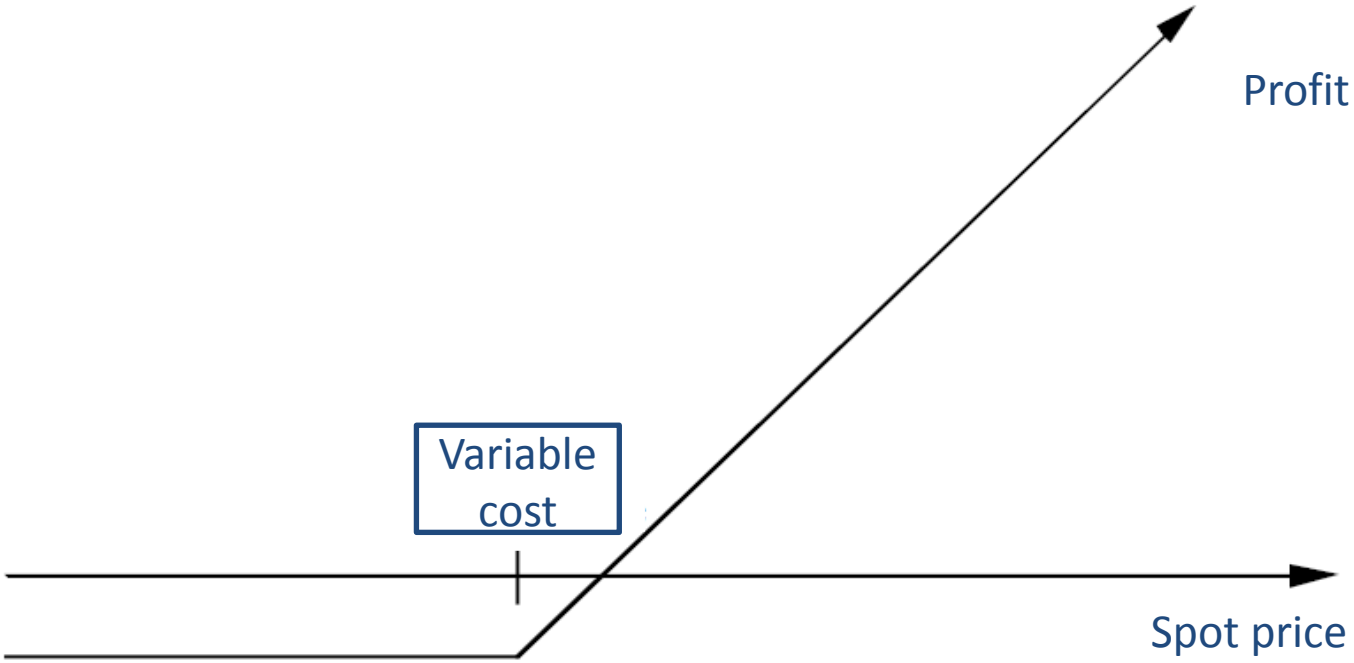
# Model specification

A monthly mean reversion stochastic process with a conditional heteroskedasticity variance model is proposed to model the zero-mean logarithm spot price

$$Y_t = \ln(P_t) - \ln(\overline{P}_t)$$
$$dY_t = \alpha(\mu - Y_t) + dZ$$

$P_t$: *Daily spot price*
$\overline{P}_t$: *Monthly spot price mean*
$dZ$ : Variance model *process differential*

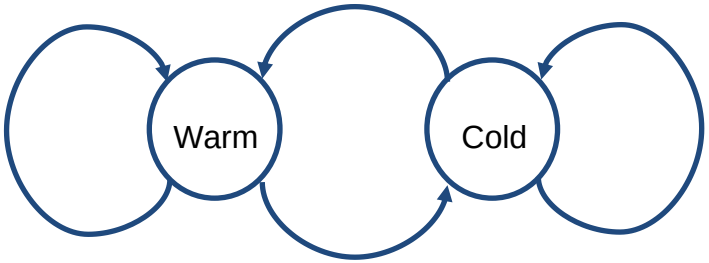
# Real options approach



# Variable cost calculation

The variable cost depends on the following factors:

- Fuel supply cost
- Cost of operation and maintenance
- Other variable costs
- Plant status (Daily)
- Start ramp (Heat rate and load)



# Future work

- A intra-day price estimation model is necessary to add the required detail to the valuation.
- Once defined a valid intra-day model that represents the electricity spot price and a variable cost calculation method, Monte Carlo simulation is used to recreate different possible trajectories, in which the real options approach is implemented.