Electricity as a Commodity

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# Contents

1 Introduction ........................................................................................................................................ 1  
1.1 History of Electricity ..................................................................................................................... 1  
1.2 Electricity and Characteristics ......................................................................................................... 2  
1.3 Markets across the World ............................................................................................................... 4  
1.4 Report Outline .............................................................................................................................. 5  
2 Demand, Supply and Supply Chain ................................................................................................. 6  
2.1 Demand ...................................................................................................................................... 6  
2.2 Supply ...................................................................................................................................... 7  
2.3 Supply chain ............................................................................................................................... 9  
3 Spot trading .................................................................................................................................. 11  
4 Forward and Option trading ........................................................................................................... 14  
5 Pricing Models ............................................................................................................................... 17  
5.1 Hourly Price Forward Curve Model ........................................................................................... 17  
5.2 SMaPS Model ............................................................................................................................ 18  
5.3 Incorporating more trajectorial properties ................................................................................... 19  
6 Trends ......................................................................................................................................... 20  
7 Conclusions ................................................................................................................................. 22  
8 Bibliography ................................................................................................................................. 23
1 Introduction

1.1 History of Electricity

Electricity had been perceived in many forms by human long before it was truly discovered and used in day-to-day life and business activities nowadays. The Egyptians’ ancient texts dating back to 2750 BC referred to the electric catfish as the “Thunderer of the Nile”. In many other parts of the worlds, lightning, an appearance of electricity in the nature, was viewed as part of a deity or a deity itself. Zeus, king of the Gods in Greek mythology, was always portrayed with a thunderbolt in his hand. One of the earliest studies on the nature and characteristics of electricity was carried out around 600 BC by “Thales of Miletos”. He made a series of observations on static electricity, in which certain objects, such as rods of amber, could be rubbed with a surface like cat’s fur to attract light objects like feathers. Thales was incorrect in believing that the attraction was due to a magnetic effect although it was proved by later science that there is a link between magnetism and electricity.

Not until the 17th century have people known more about the nature of electricity. The new Latin word “electricus” was coined by William Gilbert after his careful study of electricity and magnetism. After that, the human’s understanding on electricity had a rapid development by the contributions of a long list of many scientists and engineers including Otto von Guericke, Robert Boyle, and Benjamin Franklin. Electricity was first put into a battery format by Alessandro Volta in 1800, and then later perfected by the work of Nikola Tesla and Thomas Edison in 19th century. The development in usage of electricity was also extended to other fields, notably the discovery of bioelectricity by Luigi Galvani in 1791, and the invention of electric motor by Michael Faraday in 1821. The great progress in electrical engineering in the late 19th century put electricity to be an essential tool used in industry and modern life. It became the driving force for the Second Industrial Revolution.

In the last 30 years, we could observe another interesting dimension of the development of electricity, not in its scientific side, but in the trading side. The concept of a market for electricity trading was gotten the attentions when many governments privatised and deregulated their electricity supply industry in 1980s. New markets both for spot (not truly) and futures/options of electricity were opened, mostly in Europe, Eastern coast of the US and Canada and some in Latin America and Australia. This report will provide an analysis on the demand and supply chain of electricity, and a review on its markets and pricing models.
1.2 Electricity and Characteristics

Formal definition:

Most of us think about electricity as a good. One might say that it is a tangible good that can be stored into batteries and transferred from one place to the other. Others would say that it’s not because there is no way to see or touch electricity as a physical good. In fact both explanations are wrong. We will try to suggest a clear understanding of electricity in the following, without making it too technical.

The formal definition of electricity, or electrical energy to be precise, is the flow of charges of a particular kind. When thinking about electricity as a flow, you understand why it is related to energy. If you drop a load of steel from a roof, you observe kinetic energy. The movement or the flow, of the mass in space, represents this energy. What is the specific nature of this load or charge in the case of electrical energy? It is any kind of physical particle having the abstract property of electrical potential. The notion of electrical charge is analogue to the notion of mass; the main difference is that electrical charge can be either negative or positive while a mass is always positive. The movement of electrical charge through any kind of matter is electrical energy.

In the particular case of our study, electricity is distributed through connexion hubs, which are basically conductors. In this case, the charge is called an electron. The movement of free electrons through a metal is what we can formally call electricity.

The conclusion standing out of this reflexion may now appear simple. Imagine someone asking you to move 1000kg from one spot to the other. This task will need effort from your part and you may charge for this service. In the same way, providing electricity is a service. In that sense, we clearly figure out that electricity providers are selling a service and not a good.
What are the main characteristics of energy?

Measuring unit: there are many ways to measure electrical energy. We will stick to the unit used in electricity markets for consistency reasons. This unit is the kWh. The Watt is a unit of power. Power as it is formally defined in physics is consistent with Energy over Time. The hour is a unit of time, hence if you multiply Energy over Time by Time you get a unit of Energy. The quoted price of electricity is in fact the price for providing energy (or power during a defined period of time) in the specific form of electrical energy.

In the literature, electricity is defined as having three main characteristics that lead and explain many specific aspects of its markets. The characteristics and specificities are well represented in the next figure:

![Figure 1.1. Characteristics of electricity. Source: Burger, Graeber, and Schindlmayr: Managing Energy Risk.](image-url)

Each of the characteristic of electricity gives an implication for trading of this service. Since electricity is fungible, which means there is no difference in a unit generated by any two generators, implying that it is suitable for trading. Conduction is bounded so there cannot be a global market. It is nearly impossible to transmit electricity generated in the US to Singapore for consumption. Another unique characteristic for electricity is the lack of storability. This
requires an exact match of demand and supply at any time. Different from many other commodities, electricity forward or future contracts do not have a settlement date, but a whole period of delivery. The future contracts can be created based on the production capacity (not by storage), which means they are primitive, not derivatives. Among all types of energies, electricity is the fastest growing since it does not cause pollution when consuming. In other words, the energy is green at the point of usage.

### 1.3 Markets across the World

In this section, we will give a broad view on electricity markets across the world. Details on some spot, forward and option markets will be dedicatedly discussed in later sections. From previous part, we know that there is no global market for trading electricity because of the conduction restriction. However, we can generally classify the markets into following categories:

- **Forward and future market**: Delivery dates of traded products start from the date after the next trading day.
- **Day-ahead market**: The contracts traded in this market are delivered in the next day, and the next trading day if the two dates are different.
- **Intra-day market**: This is the market for products delivered on the same day. The market is not suitable for pure trading purpose, but for physical trading.
- **Balancing and reserve market**: This market is limited for the Transmission System Operators (TSO) and some merchants to buy or sell additional energy (in real time) to balance their supply and demand. The balancing of supply and demand will be described in section 2 when we discuss the supply chain, however the balancing and reserve markets are not discussed in this report.

The day-ahead and intra-day markets are considered to be spot markets for electricity. Figure 1.2 below depicts the map of energy exchanges where electricity is actively traded:
It is clear that electricity markets are more developed in Europe, East Cost of North America. Some exchanges are also present in South America, Australia and New Zealand. The electricity markets have not yet been well developed in Africa and Asia. The reasons may be due to the lack of privatisation and more rigid regulations in the sector.

1.4 Report Outline

The subsequent sections of this report are organized as follows. Section 2 analyses the demand, supply of electricity as well as its supply chain. In Section 3 and 4, we are going to discuss in depth the spot, forward and option markets. We review some pricing models for electricity in section 5. Before closing up the report, we also discuss the development trends of electricity trading in section 6. The last section concludes our report.
2 Demand, Supply and Supply Chain

In this section, we are going to discuss the supply chain of electricity together with forecasts of its demand and supply.

2.1 Demand

Electricity seems to be all around us, but actually there are about 1.5 billion people in the world who do not have or have very limited access to it, according to the International Energy Agency’s estimate in 2008 [1]. This implies that the demand for electricity has a good room to grow. The growth in total electricity consumption for the period up until 2030 was published by the US Energy Information Administration (EIA) in their International Energy Outlook 2006:

![Graph showing world net electricity consumption 2003-2030](image)

Figure 2.1. World net electricity consumption 2003-2030. Source: EIA - International Energy Outlook 2006

The annualised growth rate was estimated to be 2.7%, from 14,781 TWh in 2003 to 30,116 TWh in 2030. The non-OECD countries, leading by China, account for 71% of the world’s projected growth and OECD, leading by the US, countries 29%. The forecasted growths for non-OECD and OECD countries are respectively 3.9% and 1.5%.

As shown in Figure 2.2, the composition of electricity consumption is industry (42%), households (27%), services (23%) and other (8%).
The demand for electricity for a region is varied in patterns of daily, weekly and seasonal period. Most residential and industrial activities consume less energy during the night and the weekend. In tropical countries, more electricity is needed in summer to run air-conditions while countries in temperate zone need more during the winter mainly for heating purpose. The analysis of demand patterns is extremely important in electricity market. The lack of storability requires at all time an exact matching of supply to the demand. The fluctuations of demands depend also on some other uncertainty factors, such as weather or global irradiance.

2.2 Supply

Total electricity generation is projected also by EIA. The latest forecasted figures are published in its International Energy Outlook 2010. The supply increases (in trillion KWh) from 18.77 in 2007 to 31.65 in 2030 and 35.18 in 2035 at a rate of 2.3% per year. Together with the data in previous section, we can see that the projections for supply and demand are closely matched.

Similar to growth in demand, increase in supply is also led by the non-OECD countries, notably China and India. The annualised growth rates of OECD and non-OECD are forecasted to 1.1% and 3.3%, respectively.
The generation by energy source is also projected by EIA in the same report. The agency forecasts that there will not be much change in the composition of energy used. Coal will still be the most used resource to generate electricity. It is followed by renewable sources, natural gas, nuclear, and oil and other liquids in that order.

Figure 2.3. World electricity generation by fuel 2007-2030 (TWh per year). Data from EIA – International Energy Outlook 2010.

Figure 2.4. Generation by energy source 2007-2035 (TWh per year). Source: EIA - International Energy Outlook 2010.
2.3 Supply chain

In this section, we will describe the supply chain of electricity which is very unique comparing to all other commodities. The participants as well as the flows of electricity and information are depicted in the following chart:

![Electricity supply chain diagram](image)

**Figure 2.5.** Electricity supply chain

We list all the energy resources which are used to generate electricity in the supplier side. The list includes coal, nuclear, renewables, natural gas, and oil and other liquids. The power plants transform these energies into electricity. In the distribution side, Transmission System Operators are the centred entity, which, with its grid of wires and infrastructures, are in charge of distributing the electricity to consumers. The customers are classified into industry, household, services, and others. Wholesalers are technically the same as TSO, but smaller. To facilitate the efficiency of matching supply and demand, electricity markets are created so that contracts can be easily bought and sold by the power plants, TSO, wholesalers, and some big consumers. Of course, there is no physical flow into or out of the market, as indicated in the figure.

One of the most important flows in the supply chain of electricity is the balancing of supply and demand which is carried out by TSOs. Each TSO measures the averaged usage (load
profile) of its customers during a period called the balancing period. This information is sent back to the power plants so that they can generate an amount which is closely matched the demand. This discrete-time process results in a piece-wise delivery function of electricity. The process can be visualised in the following figure:

![Diagram: Supply and Demand balancing]

**Figure 2.6.** Supply and Demand balancing. Source: Burger, Graeber, and Schindlmayr: Managing Energy Risk.
3 Spot trading

As it has been introduced earlier, the Spot market is divided into two different markets: The Day ahead market and the Intra-day market. Both of these markets include organized exchanges and OTC transactions. Most of the spot products are traded in the day ahead market. These products are also the underlying products for forward and future contacts. For this reason, it is more relevant for us to focus on the day ahead products.

The spot market can be very segmented. Prices may differ over time and space for reasons related to characteristics of electrical energy. One of the characteristics of electricity is that it is conduction bounded. This leads to the fact that every market is separated from the others and that there is no way to make transactions between different markets. As a result, prices differ from one market to the other, depending on its specific demand and offer. Nord Pool Spot market is the largest one in the world and also the one providing the richest data. Since the aim of this exercise is not to exhaust all the sport electricity markets, attention will be focused on this particular one with no loss of relevancy for the study.

Nord Pool Spot or NPS is divided into two markets:

**The Elspot Market** is the primary market where prices for all the products are set up. The products are hourly contracts, which means that 24 different kinds of contracts are traded everyday, one for each hour, for delivery the next day.

Prices in this market are fixed by a bidding system. Participants have until noon to place orders for the 24 different contracts then the auction is closed. The aggregate offer and demand curves’ intersection points define the prices. Since this is a physical market, in case of congestion (i.e. volumes agreed to be delivered in a specific location at a specific time are higher than the volume that can be transported by the local TSO), different *area prices* may be quoted for the same hour of delivery according to different areas. In case of no such capacity constraint, one price is quoted per hour; this price is called the *system price*.

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1 All the data used in this part has been downloaded from www.nordpoolspot.com
Figure 3.1 Elspot System prices and Norway 1 Area prices.

In the figure above, we clearly see that for some hours, area prices may differ from the System price. For clarity reasons, we only one area, the following figure includes all of them.

Figure 3.2 Elspot System prices and all Areas prices.
The Elbas Market is the second NPS market and acts as the actual trading market. Once the auction process on Elspot decides the prices of the contracts, the results are published and Spot trading for the next day starts on the intraday market Elbas. Participants can trade contracts until one hour before their delivery time. In the meanwhile, they can also start placing bids on Elspot for the day after. We understand that Elbas is always running in parallel with Elspot. The difference is that contracts traded in Elbas have been originated on Elspot one day before. Another way to present it is that tomorrow will be traded on Elbas the contracts that are being agreed today on Elspot.

We can understand how works the NPS in a different way: From the point of view of a participant. Let’s think about an electricity retailer which puts on Monday morning, a buy order on Elspot for one hour of electricity delivery Tuesday from 3pm to 4pm at the price of 63€ or lower. At noon, after aggregation of all the bids, it turns out that the System price for this time slot is 62€. Then he has automatically bought the one-hour of electricity supply at this price. If he waits until the delivery time, the energy will be supplied to him via the TSO he is connected to. It could happen that he overestimated the demand from his clients and that he doesn’t need this energy anymore, another option for him is to trade this contract on Elbas starting from immediately until one hour before delivery, Tuesday at 2pm. He may sell it above or beyond the 62€ price he paid for it, depending on offer and demand in the same way stocks are traded.

![Elspot prices compared to Elbas last prices.](image_url)

**Figure 3.3** Elspot prices compared to Elbas last prices.

It could be interesting to compare this process with an IPO and try to find some analogies, in the very first time series, between the behaviour of stock prices after an IPO and the behaviour of an electricity contract when it enters Elbas. The main difference of course is that there is no such thing as a delivery date for a stock. Electricity has to be consumed.
4 Forward and Option trading

The spot products that have been introduced before are also playing the role of underlying products for electrical energy derivatives. We will present the most relevant contracts in the following. For consistency reasons, we will present derivatives on Nord Pool Spot products. These products are traded on Nasdaq OMX Commodities, the world’s largest power derivatives exchange.

The exchange offers a wide range of products in the following categories: Forward contracts, Futures contracts, Contracts for Difference and Options. All these products share the following properties:

- Minimum contract size: 1 MW
- Minimum ticker size: 0.01
- Currency: EUR
- Reference price: Nord Pool Spot day-ahead price
  Monday through Sunday, 00:00 to 24:00 for Base load
  Monday through Friday, 08:00 to 20:00 for Peak load

One should also note that the clearinghouse is the contractual counterparty in all contracts traded at NASDAQ OMX Commodities Europe.

Following are the details specific to each of these products:

### Future contracts:

<table>
<thead>
<tr>
<th>Load</th>
<th>Delivery period</th>
<th>Starting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base load</td>
<td>1 day</td>
<td>In 2, 3, 4, 5, 6, 7, 8 or 9 days</td>
</tr>
<tr>
<td>Base load</td>
<td>1 week</td>
<td>In 1, 2, 3, 4, 5, or 6 weeks</td>
</tr>
<tr>
<td>Peak load</td>
<td>1 week</td>
<td>In 1, 2, 3, 4 or 5 weeks</td>
</tr>
</tbody>
</table>

Table 4.1 Nasdaq OMX Commodities Nord Pool Futures specificities

Futures contracts are marked-to-market on a daily basis, which every day involves financial settlements by the counterparties if needed. The final spot reference settlement occurs after expiry date.

Delivery in electricity markets does not occur on a single date but covers a range of time, called the delivery period. This period can be one day or several months. For this reason, counterparties’ accounts are credited /debited according to the difference between the spot market price and the futures contracts final closing price.

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2 Descriptive information in this part is an aggregate from:
www.nasdaqomxcommodities.com
Forward contracts:

<table>
<thead>
<tr>
<th>Load</th>
<th>Delivery period</th>
<th>Starting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base load</td>
<td>1 month</td>
<td>In 1, 2, 3, 4, 5 or 6 months</td>
</tr>
<tr>
<td>Base load</td>
<td>1 quarter</td>
<td>In 8, 9, 10 or 11 quarters</td>
</tr>
<tr>
<td>Base load</td>
<td>1 year</td>
<td>In 1, 2, 3, 4 or 5 years</td>
</tr>
<tr>
<td>Peak load</td>
<td>1 month</td>
<td>In 1 or 2 months</td>
</tr>
<tr>
<td>Peak load</td>
<td>1 quarter</td>
<td>In 1, 2 or 3 quarters</td>
</tr>
<tr>
<td>Peak load</td>
<td>1 year</td>
<td>In 1 year</td>
</tr>
</tbody>
</table>

Table 4.2 Nasdaq OMX Commodities Nord Pool Forwards specificities

Because these contracts are Forward contracts, they do not require daily settlement like Futures contracts. Nonetheless, and this is a specificity of this market, the contracts are said to be “cascaded” into smaller maturity contracts. The cascading process is the process of splitting year contracts into quarter contracts and quarter contracts into month contracts. No settlement is needed during the trading period; the marked-to-market is accumulated as a daily P&L and realized in the delivery period.

![Cascading Process Diagram](image)

**Figure 4.1** Nasdaq OMX Commodities cascading process for Forward contracts.

Exactly like described before for Futures contracts, settlement is carried on during the delivery period.
**Options:**

Two kinds of options are available at Nasdaq OMX Commodities for the Nord Pool electricity market: The very simple basic European style Call and Put Options.

<table>
<thead>
<tr>
<th>Load</th>
<th>Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base load</td>
<td>1 or 2 quarters</td>
</tr>
<tr>
<td>Base load</td>
<td>1 or 2 years</td>
</tr>
</tbody>
</table>

**Table 4.3** Nasdaq OMX Commodities Nord Pool Options specificities

The underlying for these options is the contract with the relevant maturity date. For example, the underlying contract for the option expiring in December 2015 is the contract maturing in December 2015. All the underlying contracts are base load contracts.

**Contract for Difference:**

Futures, Forwards and Options markets on Nord Pool are often referred to as the “financial market” as opposed to the “physical market”. This is due to the fact that settlement occurs in cash. The combination of these products makes it possible to elaborate efficient strategies to manage the risk steaming from power trading. What about professionals who deal with physical delivery?

These members of the market are exposed to a basis risk representing the difference that could exist between the System price and their Area price. For this reason, we find in the market contracts that are used to hedge against this risk, called Contracts for Difference. Combined with Futures, Forwards and Options, the CfDs help to build very efficient sophisticated strategies.

<table>
<thead>
<tr>
<th>Load</th>
<th>Area</th>
<th>Delivery period</th>
<th>Starting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base load</strong></td>
<td>Oslo, Tromsø, Stockholm, Luleå,</td>
<td>1 month</td>
<td>In 1 or 2 months</td>
</tr>
<tr>
<td><strong>Base load</strong></td>
<td>Sundsvall, Malmö, Helsinki,</td>
<td>1 quarter</td>
<td>In 1, 2 or 3 quarters</td>
</tr>
<tr>
<td><strong>Base load</strong></td>
<td>Copenhagen and Århus</td>
<td>1 year</td>
<td>In 1, 2 or 3 years</td>
</tr>
</tbody>
</table>

**Table 4.4** Nasdaq OMX Commodities Nord Pool CfDs specificities
In this section, we will give a very brief introduction to electricity pricing. We do not aim to provide an in-depth review or comparison of pricing models since it would be much beyond the scope of this report. We also choose an approach which is rather intuitive and avoids the complexity of mathematics. In short, we hope this section will be a good starting point for readers who are interested in pricing electricity.

In order to build a pricing model for electricity, we first need to understand the features of its price. Some of the main key features relevant to electricity are:

- **Trend**: The movement of electricity prices is influenced by seasonal patterns and periodicities. The common periods are daily, weekly and seasonal.
- **Mean-reversion**: A deviation from the average trend (especially in form of a price spike) will initiate the tendency to revert back to that average trend.
- **Price spikes**: A phenomenon in electricity market where an upward jump in price shortly followed by a steep downward. The reason for the existence of spikes may be due to the lack of storability such that the balance between supply and demand cannot be smoothened.
- **Fluctuation around the average trend**: Unpredictable small random moves fluctuate around the average trend. This can be represented by a white noise.
- **Dependent on volatility**: This property is shared by most market. There is a strong correlation between price and volatility levels.
- **Long-term non-stationary**: Electricity generation depends heavily on the fuel costs, and this is not easy to predict in long-term future, which imposes non-stationary on electricity prices.

In the next sub-sections, we are going to introduce three models for pricing electricity.

### 5.1 Hourly Price Forward Curve Model

In every electricity contract, the delivery does not just happen on some specific date, but over a period between two dates. Let this delivery period be \([T_0, T_N]\), where \(N\) represents the number of hours of the period. If an hourly delivery schedule \(L(T)\) can be determined for this period \((T_0 \leq T \leq T_N)\), we can estimate the spot price at time \(t\) as the present value at \(t\) of all delivered amount times its respective at-that-time price:

\[
V(t) = E_T \left[ \int_{T_0}^{T_N} e^{-r(T-t)} L(T) S(T) \, dT \right]
\]

If \(L(T)\) is deterministic and discrete in hourly steps, then:
\[ V(t) = \sum_{i=0}^{N-1} e^{-r(T_i-t)} L(T_i) E_t[S(T)] = \sum_{i=0}^{N-1} e^{-r(T_i-t)} L(T_i) F(t, T_i) \]

, where \( F(t, T_i) \) is the forward price at time \( t \) for an hourly contract starting its delivery at \( T_i \). Of course, this hourly forward curve is not available in the market. One approach is break down the quoted forward prices into hourly prices using weights estimated from historical hourly spot prices. Historical patterns (daily, weekly, seasonal) should also be incorporated in the estimation.

The advantage of this model lies in its simplicity. However, the approach itself is rather ad-hoc which tries to capture the statistical features of electricity prices. Trajectorial features like spikes cannot be captured while mean-reversion is very much dependent on the historical data, yet it is not a reliable way to capture this property itself.

### 5.2 SMaPS Model

The Spot Market Price Simulation (SMaPS) [2] is a three-factor model for pricing the spot price of electricity which has the ability to capture most of the required key properties. The fundamental equation of the model is:

\[ S_t = \exp(f(t, L_t/v_t)) + X_t + Y_t \]

, where:

- \((X_t)_{t \geq 0}\) is the short-term variation process.
- \((Y_t)_{t \geq 0}\) is the long-term variation process.
- \((L_t)_{t \geq 0}\) is total load (demand) process.
- \(f(t, \cdot), t \geq 0\) is the (logarithmic) price load curves
- \(v_t, t \geq 0\) is the average relative availability of power plants.

Intuitively, the model encompasses three factors: the load factor \((L_t)\) is transformed into a component of price by an empirical function \(f(t, \cdot)\) which captures the influence of load and technicalities on prices; while other influences like the psychological aspects of the behaviour of speculators are modelled by the short- and long-term variation processes \(X_t\) and \(Y_t\). The deterministic availability function \(v_t\) can be estimated from the operation schedule of the power plants. The parameters for \(L_t\) are estimated directly from the load data monitored by market participants, while those of \(X_t\) and \(Y_t\) are determined from the data on electricity futures.

A lot of other choices and calibrations are required to make the model to work. For more details, it would be best to refer to the original introduction of the model by Burgery et al. 2004 [2].
5.3 Incorporating more trajectorial properties

In this section, we also give a brief introduction for a class of more recent and advanced models which directly capture the trajectorial properties of electricity properties. The models’ general equation includes terms each of which captures a property: trend, mean-reversion, noise, spikes.

For better understanding the approach, we will take a look at a representative model. Geman et al. [3] proposed a model with the following dynamic for the spot price process:

\[ dE(t) = D\mu(t)dt + \theta_1 [\mu(t) - E(t^-)]dt + \sigma dW(t) + h(t^-)dJ(t) \]

, where \( D \) is the first-order derivative equation and \( f(t^-) \) is the left limit of \( f \) of at time \( t \).

Meanings of equation terms are:

- \( \mu(t) \) represents the seasonal trend.
- the second \( dt \) term ensures mean-reversion property.
- \( dW(t) \) term represents the price fluctuation around the average trend (white noise).
- \( dJ(t) \) term represents the jump process which is used to model price spikes.

Clearly, the equation of the model is very intuitive in the sense that each of its terms is used to describe a key property of electricity prices.

As mentioned from the beginning of the section, we will not go into further details due to the complexity of the models. Interested readers should refer to the original sources for in-depth understanding.
6 Trends

One interesting thing to view when we deal with Future/Forward contracts in a commodity is the forward price curve. This curve usually embeds a lot of information about the specificities of the product. Here is an attempt on Electricity contracts:

*Figure 6.1* 18/03/2011 forward curve for Nord Pool month-contracts

*Figure 6.2* 18/03/2011 forward curve for Nord Pool year-contracts

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3 Forward prices data from Bloomberg.
The main trend we can notice here is the overall direction of the curve. It tends to be on backwardation, especially for long periods such as years. This feature makes sense since there is no advantage from holding electricity, like holding gold. This is not due to the fact that Electricity does not provide any convenience yield. Electricity is not storable so there is no existence of such notion.

The second aspect is unveiled in the following curve:

![Figure 6.3 18/03/2011 forward curve for Nord Pool & Portugal quarter-contracts](image)

In this graph we clearly notice the appearance of cycles. Every year seem to experience an upward and a downward slope in the curve. This is explained by a very notion. Electricity prices are very linked to seasons. For this reason, we experience:

- High prices during the winter for the Nord Pool.
- High prices during the summer for Portugal.

While Portugal will experience high demand for cooling systems during summer, countries such as Sweden will reach the highest demand during the winter for heating.

The third and last observation is that, obviously, prices are different in two different markets. The reason for this phenomenon has already been explained before: Electricity is conduction bounded, which means that there is not a global market.
7 Conclusions

In this report, we have reviewed a special commodity: electricity. The specificities of the product impose markets structures and pricing methods different from other commodities. The non-storability property separates the link between forward and spot prices. It also requires pricing models to account for not just a delivery date, but a whole period of delivery. We have also discussed the forecasted supply and demand of electricity as well as the development trends in its market. No global market exists due to the bounded conduction; however, all types of markets have been developed in some part of the world. They will continue developing and promise to extend to other regions when more deregulations happen to facilitate the efficiency of trading.
8 Bibliography


