KADİR HAS UNIVERSITY

GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

ENERGY TRADING IN TURKISH POWER MARKET THROUGH OPTIONS, BILATERAL AGREEMENTS AND SPOT MARKET

Master Thesis

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Abstract

In today's world, electricity energy, which has a vital place in energy market, is irreplaceable in any field because of being the basic entry in production factors and because of continuous increasing demand to electricity thanks to technological development. Especially in our country, which has a rapid acceleration for the last decade, by reorganizing Electricity Energy Market it is aimed to build a competitive structure in production and retail transactions. Also, with the process of development in Turkey, the structure of the market changed, varied and created different alternatives for efficient buying-selling transactions. In this work, we built a model on the purpose to find the solution of the most efficient scenarios and maximum efficiency by using electricity spot market, which has transactions with a determined capacity limit, derivatives market and bilateral agreements. The amount of efficiency is calculated by using the Model for each 100 different power scenarios' in Excel and the results are got and interpreted. As a result of this, the most efficient scenario determined.

Key Words: Optimization, Electrical Energy, Turkey Electric Industry, Market Power, Spot Market, Derivatives Markets, Options, Bilateral Agreements

ENERGY TRADING IN TURKISH POWER MARKET THROUGH OPTIONS, BILATERAL AGREEMENTS AND SPOT MARKET

Özet

Günümüzde, enerji piyasası içerisinde önemli bir konumu olan elektrik enerjisi, gerek üretim faktörlerinde temel girdi olması, gerekse teknolojinin gelişimiyle birlikte elektrik enerjisine olan talebin sürekli artmasından dolayı her alanda vazgeçilmez bir ihtiyaç haline gelmiştir. Özellikle son 10 yıldır iktisadi büyümede çok hızlı ivme kazanan ülkemizde, Elektrik Enerjisi Piyasaları ise yeniden yapılandırma süreciyle üretim ve satış faaliyetlerinde rekabetçi bir yapının oluşturulmasını amaçlamaktadır. Ayrca, Türkiye deki gelişim süreciyle piyasaların yapısı şekillemiş, çeşitlenmiş ve farklı alternatifler doğurarak karlı alım-satım işlemleri gerçekleştirilmeye başlanmıştır. Bu çalışmada, belli bir kapasite sınırıyla şu an işlemde olan elektrik spot piyasası, vadeli işlemler piyasası ve ikili anlaşmalar sözleşmesi kullanılarak en verimli senaryoyu ve maksimum karı sağlayan çözümü bulmak üzere bir model oluşturulmuştur. Oluşturulan model 100 farklı kapasite senaryosu için Excel uygulaması kullanılarak sonuçlar alınmış, ve sonuçlar yorumlanarak beklenen kar miktarları hesaplanmış ve bunun sonucunda en karlı senaryo belirlenmiştir.

Anahtar Kelimeler: Optimizasyon, Elektrik Enerjisi, Türkiye elektrik piyasası, Piyasa gücü, Spot Piyasası, Vadeli İşlemler Piyasası, Opsiyon, İkili Anlaşmalar

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List of Abbreviations

GNP: Gross National Product

EPK: Electricity Market Law

SMF/SMP: System Marginal Price

DUY: Electricity Market Balancing and Settlement Regulations

VOB/TURKDEX: Turkish Derivatives Exchange

TEK: Turkish Electricity Institution (Türkiye Elektrik Kurumu)

BOT: Build-Operate-Transfer (Yap-İşlet-Devret)

BO: Build-Operate (Yap-İşlet)

TOR: Transfer of Operational Rights (İşletme Hakkı Devri)

PMUM: Financial Market Reconciliation Center (Piyasa Mali Uzlaştırma Merkezi)

EMRA/EPDK: Energy Market Regulatory Authority (Elektrik Piyasası Denetleme Kurumu)

TEAŞ: Turkish Electricity Transmission Incorporation (Türkiye Elektrik Üretim Anonim Şirketi)

TEDAŞ: Turkish Electricity Distribution Incorporation (Türkiye Elektrik Dağıtım Anonim Şirketi)

EÜAŞ: Electricity Generation Incorporation (Elektrik Üretim A.Ş.)

TEİAŞ: Turkish Electricity Transmission Incorporation (Türkiye Elektrik İletim A.Ş.)

TETAŞ: Turkish Electricity Trade and Contracting Incorporation (Türkiye Elektrik Ticaret ve Taahhüt A.Ş.)

YAL: Take Load (Yük Alma)

YAT: Bleed off (Yük Atma)

SGÖF: System Day-Ahead Prices

HES: Hydroelectric Plants

ÖİB: Privatization Administration (Özelleştirme İdaresi Başkanlığı)

YPK:	High Planning Council (Yüksek Planlama Kurumu)
IMKB:	Istanbul Stock Foreign Currency (İstanbul Menkul Kıymetler Borsası)
PTF/MCP:	Market Clearing Price (Piyasa Takas Fiyatı)
KPTF:	Unrestricted Market Barter Prices
GWh:	Gigawatthour
KWh:	Kilowatthour
MWh:	Megawatthour

List of Notations

k	=	Price Scenario
K	=	Number of Price Scenario
i	=	Power Scenario
I	=	Number of Power Scenario
t	=	Hour Index
Q	=	Power Produced
O	=	# of Options Sold
P_t	=	Power Spot Price at Hour t (TL/MWH)
X	=	Strike Price of the Option (TL/MWH)
C(Q)	=	Cost Function of the Power Generator
a,b,g	=	No load, Load and Fuel Cost Coefficients
Q_{cap}	=	Capacity of Power Produced
h	=	Number of Hours in a Day
R	=	Revenue

Chapter 1

Introduction

The most basic and the gripping element of economic and social development of the countries is energy. It is impossible to imagine a life without energy in today's modern societies. Throughout the ages, the changing needs and emerging technological advances has changed and diversified the raw materials of the energy. Especially after 18th century, desire of having energy sources is the main argument that shaped world policy. For this cause, the political struggles were replaced by overall power and the world wars that cause many human dramas and conflicts filled the pages of history and it still continues to fill.

Energy is the most important resource that economy and societies need in order to maintaining the living conditions. The place of energy is increasing in society. The rapid development of technology, the increasing usage of energy in transportation and increasing demand of energy in industrial raw material made energy key part of human life. Energy's rate with the world GNP continues to grow with the economy.

The problems in the countries that supply energy, causes fluctuations in energy prices. Those fluctuations cause an increment in energy risk. In recent years, increasing demand for Electrical Energy, particularly in developing countries, is another reason of energy risk. By increasing deregulation works and beginning of determining prices under free market conditions in energy market all around the world, the concept of price risk is introduced in these markets. Buyers and sellers in the energy markets need effective risk management tool in order to avoid negative effects of price fluctuations.

On the other hand, Electrical Energy is no doubt the indispensable source of the economy and living standards. But, the main problem is providing continuous and safe energy to consumers. Production and continuous growth of production is required in order to provide healthy growth of the economy.

Electrical Energy which is almost field of interest of every discipline is a kind of sea when energy’s core and the issues associated with energy is thought. Electrical Energy markets are also vital for our country which has the strategic importance of natural and energy located routes. Therefore, process in the energy sector must be examined objectively and financially and revealing the effects to our country objectively is very important.

Since 1980s, the reengineering movement has gained acceleration and thus electricity has gained a place in market. So that, economical decisions are determined by many authorities and physical flowing is directed by system operator in the new structure, which used to be central flowing.

It is pretty important to build new markets during the process of gaining a place in market. The very important reason is, as given above, that electricity has its special and unique qualities rather from other goods. During the process of gaining place in the market of electricity, the instantaneous prices can increase quite different from other markets. Price fluctuations have great risks for authorities and this must be managed in a way.

The law was made in 1984, led to divestment in monopole structure and then the main acceleration in rebuilding the electricity sector was gained in 2001 with Electricity Market Law (EPK). Hence Electricity Market Balancing and Settlement Regulations (DUY) was practiced in 2006 and thanks to it the marketing of electricity in Turkey took a step and then in 2011 Derivates Exchange (TURKDEX) was founded, which is the first electricity future contracts. Yet already, as well as electricity marketing organization is at its beginning steps the main aim is to supply an electricity stock market that has a well-working and adequate liquidity and a platform that customers and manufacturers can manage the risks.

This thesis mainly focuses on the structure and operation of the electricity market, which is a sub-sector of the energy sector, application of practice in Turkey and, the chance of trade of derivatives markets, spot markets and bilateral agreements in the electricity market.

From this view, the primary aim of this project is to find the financial structure and the optimum result of this structure which derived from the alterations of electricity marketing. At the third stage, we will have a panoramic view of Electricity Energy and its History and on the fourth stage the structure and component of electricity markets. On the 5th stage, on which we will explain how the bilateral agreement, spots and derivatives are done, the examples of the transactions will be shown.

Our operational aim in this thesis is gain maximum efficiency by selling electricity marketing; spot market, derivatives market and bilateral agreements. Through this we should the general model into 3 grounds. First of all, we built a formulation in order to sell the production by the ways of derivatives market, bilateral agreements and spot market. Briefly, at the 6th section we will give information about the formulization of models those are built regarding 3 marketing selling.

After reaching the optimum results for each selling style, we will have the aim to produce scenarios to gain the maximum efficiency by our models. For this, at the 7th section we will explain all models and solution ways. On the Excel table the working principle of the system and restrictions will be talked about. Then, at the 8th section the most efficient approach will be determined from Excel simulation.

In the final, the general evaluations of the preceding stages' results will be held.

Chapter 2

Literature Review

In this section, we will examine Turkish Electricity History and articles about markets and theirs structures scientifically. Firstly, Akcollu, (2003) brings forward proposals for presenting special features of electricity and electricity supply industry, for stating applications of regulation and building competition, for determining the points in order to make up a competitive industry by benefiting from the experiences of both theoretical and practical knowledge and for making an observation about structuralism reforms in Turkey.

Furthermore, Akcollu, (2003) discusses the regulator foundations and their relationships with competitor foundations in her work. She states some important suggestions to help reorganization movements in electricity sector in Turkey being parallel with other countries.

Camadan and Erten, (2010) deal with the problematic in changing market structure framework and before producing- privatization. The very intriguing approaches are handed out by Turkish electricity market. In the article, the notion of "market power" is focused on and calculating the market power methods are touched on. Farther, Turkish market power is calculated and the probable effects of new structure are referred.

According to Unal, (2007) analyses the structure, mechanism and practice of Turkey and the world of electricity market, which is the branch of energy sector, and also he goes through the chance for trade of derivatives financial devices in short and mid phases. The panoramic view of electricity market, world's alternation process of electricity market and electricity market variations are detailed in this work. Moreover, Turkish electricity market is tackled with every ways and the effects of this process for Turkey for now and for the future is discussed.

Ozen, (2008) explains that pricing of forward transaction and showing the differences between forward markets and spot markets up in details. Examining the improvement and mechanism of forward transactions in both Turkey and the world, he brings out the effects of forward transactions over spot market activity.

Erdogan, (2006) tests the validity of the model retrograde by measuring the risks of the portfolio that is built up from energy derivatives agreements and by searching whether it is implementable or not to use derivatives goods. Besides, he gives information about the general structure of derivatives markets.

Herguera, (2001) explains the evolution of volumes and prices traded in both markets, i.e. the spot and the bilateral contracts market, in two different experiences, i.e. the NordPool and England and Wales. He proposes an interpretation of the evolution observed: based on the theoretical results proposed by Allaz and Vila (1993) and Green (1999) that link the performance of the spot and the bilateral markets, he emphasizes the pro-efficiency implications derived from the introduction of a bilateral contracts market.

Hausman, Hornby, and Smith, (2008) mention that the energy market, the features of derivatives agreements and goods, and the structure of risk in the market and the managing of risks in electricity market. The article explains what and how is Bilateral Agreements in their work and advantages and disadvantages of it by giving importance to its ratio in world's usage.

Chung, Zhang, Yu and Wong, (2003) mention that design of forward contracts bundled with financial options for electricity market risk management. In a competitive electricity market, traditional regulated interruptible energy supply services are replaced by voluntary participant responses to electricity spot prices. In this new environment, participants wishing to ensure a fixed electricity price while taking advantage of their flexibility and willingness to curtail load or supply may do so by using a forward contract bundled with financial options that provides a hedge against price risk and reflects the real choices available to the participants. A forward contract bundled with financial options, or optional forward contract, gives the option holder a right, but not an obligation, to purchase or sell the contracted energy at the delivery time for a given price, called the strike price. This enables the option holder to hedge against the risk of profit loss when market prices move in an adverse direction, while retaining the ability to participate in a favorable market if prices do not move in that direction. Hence the optional forward contract is by nature more flexible.

David and Wen, (2001) in their article talk about various definitions of market power. In general, market power is referred to as the ability of a market participant to profitably maintain prices above a competitive level for a significant period of time. A company has market power if it can influence the market equilibrium point. Where there is a price maker, there is some degree of market power. Market power may range from a full market to a local market. Market efficiency is obtained through competition. Market power is undesirable as it is a symptom of an uncompetitive industry and can lower economic efficiency. While the manifestation of market power abuse is usually associated with a higher price above cost, it can also be lower quality of products or services compared to what would be found in a more competitive environment. Thus, it is not always reliable to measure market power by calculating the percent price rise above cost. Attempting to defer entry of competitors is also a manifestation of market power. Moreover, market power is not limited to sellers. Buyers too have market power; for example, large customers have more ability to affect pricing than smaller ones.

Baughman and Lee, (1992) mention that a model which is presented that calculates spot market prices using the theory of spot market pricing as presented in reference with a model that combines economic dispatch calculations with load-flow and customer response functions in Monte Carlo simulation model. The model should be useful to experimenters and practitioners of spot market price.

Chapter 3

History of Electricity Industries in Turkey

3.1. Electricity Industry in Turkey

Electricity production made by water mill with 2KW dynamo at Tarsus. Beside, the first power plant was established in 1913 at Silahtaraga, Istanbul. The first period of the Republic of Turkey, investment in the electricity sector made by foreign investors due to lack of financial resources.

Adopted throughout the world in the 1930s nationalism and with electricity activities carrying out the public ownership, process of nationalization has been started in electrical industry. After that, in 1944 nearly all the electricity sector as a result of this nationalization collected under public ownership.

In 1963, Ministry of Energy and Natural Resources and in 1970 Turkish Electricity Institution (Türkiye Elektrik Kurumu-TEK) was founded. Besides distribution, Turkish Electricity Institution acted in all electricity segments and thus role as a monopoly. In 1982, municipalities were banned from distribution of electricity and as a result of this Turkish Electricity Institution's monopoly operated the national industrial electricity. Turkey internalized the exportation as the economic strategy. Kinds of alternatives and encouragement policies were created in order to incorporate private sector, as well. Turkish Electricity Institution's monopoly was deceased in 1984's law and build-operate-transfer (BOT) or transfer of operational rights (TOR) model helped them to operate in electricity business. BOT agreements were for newly founded associations whereas TOR was for the participants of private sector, but the ownership of existing production and distribution associations would belong to Turkish Electricity Institution. However, because of the bureaucratic and judicial deadlocks of the law 3096, the first great projects could scarcely begin in 1996.

Turkish Electricity Institution was severed into two in 1994: For producing and transferring the electricity Turkish Electricity Transmission Incorporation (Türkiye Elektrik Üretim Anonim Şirketi - TEAŞ) and managing the distribution Turkish Electricity Distribution Inc. (Türkiye Elektrik Dağıtım Anonim Şirketi - TEDAŞ). In 1997, private sector was allowed to build thermal associations by build-operate models. Privatization enterprises were interrupted because of Constitutional Court's judgments in 1994 and 1995. As a result, in 1999 the constitution was changed in order to realize the privatizations. (Camadan, Erten, 2010)

In 2001, it was aimed to build a mechanism in electricity business for liberal rivalry, Electricity Market Law (Elektrik Piyasası Kanunu-EPK) named 4628 rule. The aim of Electricity Market Rule was: "to regularize and assure the survey for presenting the electricity to the areas that have lack of enough, quality, regular, cheap and appropriate electricity; creating energy business in rivalry environment that is economically powerful, stable and transparent.". In the scope of this rule, Turkish Electricity Transmission Incorporation divided into 3:

- Electricity Generation Incorporation (Elektrik Üretim A.Ş.-EÜAŞ), for producing electricity,
- Turkish Electricity Transmission Incorporation (Türkiye Elektrik İletim A.Ş.-TEİAŞ), for transmission of electricity,
- Turkish Electricity Trade and Contracting Incorporation (Türkiye Elektrik Ticaret ve Taahhüt A.Ş.-TETAŞ), for marketing the electricity.

3.1.1. The Construction of the System of The of Electricity Energy in Turkey

3.1.1.1. Production of Electricity Energy and Electricity Generation Incorporation (EÜAŞ)

Power Houses are those foundations that produce electricity energy and serve it to us, profiting from natural energy resources. The main principle in producing electricity is to alter the mechanical energy to electricity energy. The names of power plants differ according to what energy or fuel they need. For example, hydroelectric, thermal, nuclear, biogas, geothermal, winds, tidal and solar.

Hydroelectric and thermal power plants have the great part in production of electricity of Turkey (78%). The sort of power plant is depended to the first investment that determines the unit margin of energy, management and maintenance expense. The foundation expenses of thermal power plant are 2 or 3 times less expensive than a hydroelectric power plant, which has the same power. On the other hand, the management expenses of hydroelectric power plant are less. Since just expensive fuel is used in thermal power plants, management expenses are too high. Although, amortization is high in hydroelectric power plants, unit margin is lower than thermal ones.

Electricity Generation Incorporation, which is responsible for the establishment and operation of power plants in the state-owned electricity generation, at the end of 2010 with an installed capacity of 24.203 MW power, had provided 49% of the power of the Board of Turkey and 45.2% of electricity production in Turkey. Electricity Generation Incorporation also makes rehabilitations in order to increase the efficiency of thermal and hydro power plants and production capacity. By the end of 2010, Electricity Generation Incorporation owned 19 thermal and 106 hydroelectric power plants. The installed power is total of 24.203 MW which consists of 12.525 MW of thermal power and 11.678 MW hydroelectric power plant. Electricity Generation Incorporation’s electricity production is 54 GWh in thermal power plants and 42 GWh in hydroelectric power plants, which makes total of 96 GWh. With this production amount Electricity Generation Incorporation have provided approximately 45.2% of the country’s total electricity production. By the end of 2010, the distribution of production according to sources occurred like this: coal 34.7%, natural gas 22.0%, 43.2% power, liquid fuels, 0.1%.

3.1.1.2. Transmission of Electricity and Turkish Electricity Transmission Incorporation (TEİAŞ)

Most of power plants, which are built to produce electricity, are far away from consumption area. Electricity needs to be transmitted directly to the consumption area from where it is produced because of inability to store.

All the facilities, which provide the transmission of electricity to consumers from power plants, are called electric network. Transmission network provides the transmission of electricity to the consumption areas and distribution of electricity in these areas is provided by distribution network.

3.1.1.3. Distribution of Electricity and Turkish Electricity Distribution Incorporation (TEDAŞ)

Distribution of electricity is provided by Turkish Electricity Distribution Inc. and other private companies. These companies provide the electricity below 36 kV voltages to the consumers. High voltage electricity, which arrives to the distribution centers, is reduced to medium voltage and sent to factories, urban transportation systems and urban distribution network. Electricity is still in high voltage when it arrives to the near of our homes and workplaces. That's why electricity is reduced to 220 V with the help of electric transformers which are assembled on lamppost. By connecting these transformers with homes and workplaces, subscribers consume electricity by converting it to heat, light and mechanical energies. When Electricity Market Law enters in force, Energy Market Regulatory Authority (Elektrik Piyasası Denetleme Kurumu-EPDK) is founded. This foundation's name has been changed to Energy Market Regulatory Authority by law of Naturel Gas Market Law which was also taken effect at the same year.

Electricity Market Rule enabled production and wholesale trade to special sector investors with the obligation of taking license. This law aims to create a market structure based on choosing suppliers by free consumers on their own in bilateral agreements. To be able to support this market structure and remove disparities which are occurred in real time, balancing market is projected. (Ceylan, 2012)

Corporatization of electricity sector has been started in 17/03/2004 within "Electricity Power Sector Reform" and aimed to reduce cost of distribution of electricity, create competition in production, efficiency, and raise quality and investments. In this direction;

- Turkey has been split to 21 electricity distribution regions.
- 9 of these regions' corporatization process have been completed.

- Corporatization of electricity production has been started in 19/09/2009 with the decision of Privatization Administration and 52 hydroelectric plants (HES) have been come under corporatization.

- Corporatization of these hydroelectric plants will be performed in 19 groups with 49 years of operational rights.

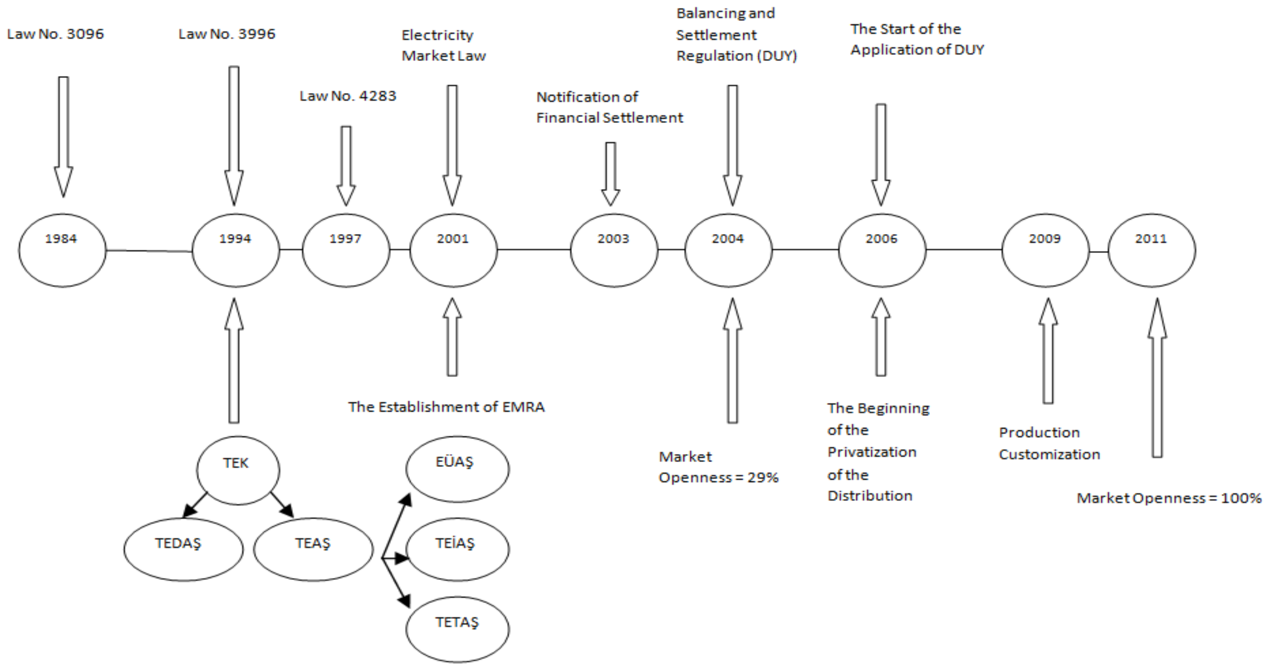


Figure 1: Milestones of Electricity Sector in Turkey [3]

There are some macro data and foresight about Turkey's electricity market, which is in a state of flux and anticipated about increasing market value, specified below;

- Yearly consumption of electricity in Turkey approached 210.000 GWh in 2010. This value is 7.9% higher than 2009 year. Energy rate request exceeded over 33.000 GWh in 2010.

- Demand of electricity has been increasing since 2001, except 2008 crisis year. Turkey is placed as the 2nd country after China about increasing value of demand between the years of 2001-2007.

- Installed power of Turkey has been increased 2.769 MW and total installed power has reached 49.562 MW. Number of working thermal plant has reached to 264, hydroelectric power plant has reached to 260 and wind power plant has reached to 39 at the end of 2010 year.

- 41% of installed power is belonged to Electricity Generation Incorporation (EÜAŞ) and 26% of installed power is belonged to other free production companies.
- 65% of installed power is based on thermal source and 32% is based on hydrolic source.
- Companies can be in service on electricity market with having a license which is taken from Energy Market Regulatory Authority. There are 1337 licenses in electricity market by the year of 2010. 921 of these licenses are for production, 199 of them are for auto producer and 124 of them are for organized industrial site.
- According to Energy Market Regulatory Authority's foresights, in the next 20 years there will be required an investment about 225-280 billion $ to fossil fuel and renewable sources according to different scenarios.
- Wholesale trade market traffic reached 330 billion KWh in 2010 and this value represents 47 billion TL economic magnitudes with the 2010 prices.
- According to Turkish Electricity Transmission Incorporation's projections, it is anticipated that Turkey's demand of electricity will increase 5% in 2011 and 7.5% for each year between 2012-2019 with the high demand scenario. According to this scenario, Turkey's yearly demand of electricity will exceed over 300.000 GWh and will be 314.796 GWh in 2016. Turkey's demand of electricity will increase 5% in 2011 and 6.5% for each year between 2012-2019 with the low demand scenario. According to this scenario, Turkey's yearly demand of electricity will exceed over 300.000 GWh and will be 303.254 GWh in 2016. (Çetinkaya, Öztürk, 2011)

Chapter 4

History of Energy Markets

4.1. Structure of Market

Electricity market activities, which are determined by Electricity Market Rule, are production, transmission, distribution, wholesale trade, retail sale, retail trade service, commerce, importation and exportation.

Transmission activity is performed by Turkish Electricity Transmission Incorporation. Moreover, Turkish Electricity Transmission Incorporation provides load distribution, frequency control, increase of needed capacity, real time monitorization of system safety.

Distribution activity is performed by companies which have the license of distribution. Distribution is performed in regions according to distribution licenses. Distribution companies can also perform this activity by having retail sale license. There are 21 regions of distributions in Turkey. Except Kayseri, 20 of them were dependant to Turkish Electricity Distribution Incorporation. But today, some of them are privatized. To illustrate, operation rights of Aydın-Denizli-Mugla electricity region has been transferred to AYDEM Electricity Inc. in 2008. Corporatizations process of Baskent Electricity Distribution Inc. and Sakarya Electricity Distribution Inc. has been completed in 2009. 100% of the stocks of these two regions has been transferred with the block sale method. Corporatizations process of Meram Electricity Distribution Inc. still has been being performed. Corporatization process of Aras Electricity Distribution Inc. has been suspended at the same period of time because of stopping enforcement decision which is taken by state council. Procurement notice for corporatization of Yesilırmak Electricity Distribution Inc. and Coruh Electricity Distribution Inc. has been published by Privatization Administration (Özelleştirme İdaresi Başkanlığı-ÖİB). (Camadan, Erten, 2010)

Production of electricity in Turkey is performed by EÜAŞ, companies which are dependant to EÜAŞ, private sector production companies, autoproducers and production companies which has agreements according to BOR, BO and TOR contracts. Sector Reform of Electric Energy and Corporatization Strategy Certificate, which was announced by High Planning Council (Yüksek Planlama Kurumu-YPK) in 17 March 2004, foresee corporatization according to "prevention of market dominance with production facilities and financially strong companies are principal criteria". In strategy certificate, it is determined that corporatization of portfolio production groups would be completed until September 30, 2005. But corporatizations process of those portfolio production groups has not been completed yet. Electricity commerce in electricity market of Turkey is performed within bilateral agreements or balancing and conciliation market. Today's market structure of electricity in Turkey is that EÜAŞ sells the produced electricity to TETAŞ. On the other hand, associations and portfolio production groups, which are dependant to EÜAŞ, sell electricity to distribution companies.

Power plants, which produce electricity within BOR, BO and TOR contracts, sell all the energy to Turkish Electricity Trade and Contracting Incorporation (TEİAŞ). Turkish Electricity Trade and Contracting Incorporation sell the electricity to distribution companies and free consumers which Turkish Electricity Trade and Contracting Incorporation procured electricity before Electricity Market Rule. If these free consumers revoke their contracts which is formed with Turkish Electricity Trade and Contracting Incorporation, they cannot purchase electricity from Turkish Electricity Trade and Contracting Incorporation (TEİAŞ) anymore. Private production companies sell the electricity they produce to free consumers and wholesale trade companies through bilateral agreements. Auto producers can also perform trade of electricity. According to Electricity Market Rule's clauses, auto producers can sell the 20% of the electricity they produce throughout the same year which specified on their licenses. In terms of supply safety, Energy Market Regulatory Authority can change this ratio according to be in need of demand. This ratio is determined as 50% by the committee for 2009 year.

Producers, autoproducers, wholesale trade companies and retail sale companies can perform trade of electricity on balancing and conciliation market. There is no corporation which has the retail trade license except distribution companies. That's why; the companies which perform commerce activity on balancing and conciliation market have the distribution license.

Turkish Electricity Trade and Contracting Incorporation participate on balancing and conciliation market in behalf of BOR, BO and TOR power plants. (Camadan, Erten, 2010)

4.2. Design of Market and Basic Concepts

Design of market contains regulations of electricity commerce involving structure and rules of market. Establishment of electricity market does not change the physical features of electricity. Design of electricity market differs from other markets because of the following features;

1. Electricity cannot be stored like other commodities.
2. Electricity is dependant to rules of physics and does not follow commerce agreements.
3. Restrictions of transmission system bring other restrictions to the process of trade.

The most important element of the design of market is the price mechanism. Design of market consists of short and long term market mechanisms according to changing prices of the market.

Electricity which we consume today is produced due to power plant investments which were performed 2-15 year time period. After the investment decision, investors establish a fuel agreement and perform maintenance plan and fuel procurement 1 year before present. Bilateral agreement and futures process markets are the major components of the design of market which help investor's needs, provides balance on prices and supply safety at the long term.

Short term market mechanism, also known as stabilization mechanism, is supplementary to bilateral agreements. It consists day-ahead market and balancing market.

Day-ahead market, is organized by a neutral stock market of electricity, provides processes of electricity trade which is going to be delivered 1 day after. Day-ahead market is also known as spot market in Europe and specifies reference prices, supply and demand values for electricity.

Balancing market, is used by transmission system manager to maintain supply-demand balance, is very important about system reliability and short term supply safety. It reflects the cost of the system disparity price which is enforced to market competitors because of energy shortage or surplus. Balancing market involves in power disparity market which is participated by production/consumer foundations and responsive in 15 minutes.

Long term market mechanism, involves in the bilateral agreement and future process markets, which performs stabilization of prices and bilateral agreements. Models of alternative energy market in today's world can be seen in detail on Figure 2. (Ünal, 2007)

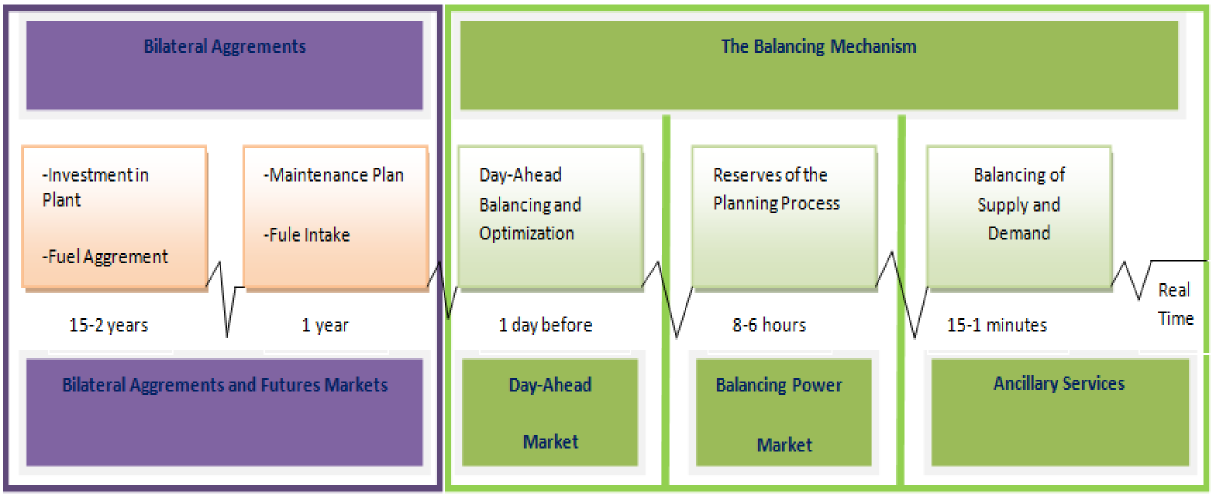


Figure 2: Turkey Electricity Market Design [3]

4.2.1. Day-Ahead Markets (Spot Market)

Power exchanges are come out results of the electricity market reforms in European Union countries which short term agreements are performed in and lower their costs to minimum. The purpose of power exchanges is to stabilize short term products' buy and sell portfolios of market competitors. When market competitors move from vertically-integrated structure with a constant price list to competitive market with unpredictable market price, they want to know the market price. Power exchange provides reference price of electricity, which is objective and assure supply-demand balance. Power exchange mixes the benefits of liberal market and needs of reliability. Clearing house, which is involved in power exchange prevents systematic risks and lowers the assurance costs of market competitors.

Nordpool-Scandinavian Power Exchange is the first and international regional power exchange which is founded in 1993. Nordpool is also the first and most successful derivatives power exchange. Consumption of electricity is processed 58% in bilateral agreements market, 40% day-ahead market and 2% in balancing market. OMEL power exchange, which is founded in Spain in 1998, has an equal transaction volume to total consumption because of using a pool model. 2% of it, is the real-time balancing market volume. European Energy Exchange (EEX) which is located in Germany and Powernext which is located in France are the most growing power exchanges. Today, EEX offers numerous of products within deliverable physical electricity agreements in Austria and deliverable futures agreements in France. Power exchanges, which are located in Europe, are listed on Figure 3.

Country/Region	Electricity Stock Market Name	Date Establishment	Share Comsuption	Futures Products
Scandinavia	Nordpool	1993	40%	/
England	UK Power Exchange	2001	10%	/
Spain	OMEL	1998	98%	
Germany	European Energy Exchange (EEXA)	2000	20%	/
Fransa	Powernext	2001	10%	/
Italy	Gestore Mercato Electtrico (GME)	2004	5%	
Slovenia	Borzen	2002	3%	
Romania	OPCOM	2000	5%	/
Austria	EXAA	2002	2%	
Poland	Polish Power Exchange	2000	1%	
Holland	Amsterdam Power Exchange (APX)	1999	15%	
Czech Republic	OTE	2002	3%	

Figure 3: European Electricity Exchanges [3]

- Day-ahead market is in active with bilateral agreement market and competes with it. Delivery of electricity, which is processed in market, is obligatory. Spot market concept, which is adopted by most of the European power exchanges, is based on supply-demand participation. Day-ahead market, which is supported by real time balancing market, lowers the risk of exposure to balancing market.

- Day-ahead market enables to manage the stabilization of energy which helps to lower the volume of balancing market. Balancing market is used for fixing unexpected variations in real time business. As a result of these, day-ahead market provides objective, reliable and unquestionable reference prices of electricity. It optimizes production and consumption.

- Even if bilateral agreements are efficient in agreement period, because of containing both medium and long term it cannot be efficient every hour or every day. Moreover, evaluation of all the resources is impossible within bilateral agreements.
- Day-ahead market lowers the cost of looking for other competitors, increases economic efficiency, helps processes are performed cost-effectively. This way, it increases the efficiency of production and consumption of electricity.
- Increases security of supply by providing timely and accurate price signals in time.
- It allows balancing portfolios to the market participants. Therefore, it shrinks real-time balancing market and reduces the balancing burden on system operator and improves system security.
- In congestion management, it provides the best usage option of constraint information and existing lines.
- It is a plan that used for offering to the day-ahead market and shows that how the market participants want to perform their production and / or consumption according to the different prices on the next day.

4.2.1.1. Financial Market Reconciliation Center

Located within the framework of the relevant legislations in Turkish Electricity Transmission Incorporation, it is the unit that calculates the debt amount or credit balance which juristic persons owe each other, by doing physical balancing with electricity supply and demand in real time by National Load Dispatch Center.

Its duties and responsibilities are clarified in Balancing and Settlement Regulation Act and it operates the day ahead planning / day-ahead market and settlement.

Financial Market Reconciliation Center (PMUM) is consists of Day-ahead planning and Balancing Power Market activities. The main purpose of Financial Market Reconciliation Center is to keep in balance the supply and demand of electricity.

Balancing mechanism is complementary to bilateral agreements. As it mentioned above, it includes the activities of the day ahead balancing and real-time balancing. Day ahead planning, until the day ahead market will be initiated, days prior to the forecasted hourly demand for the day ahead in order to balance the Market Operator under the coordination of activities. Day-ahead balancing is the system of supply and demand and/or market participants' contractual commitments with the production and/or consumption balancing plans days in advance. Balancing Power Market serves to the purpose of the balancing of supply and demand in real time, in fifteen minutes output power exchange takes place with the trade of spare capacity obtained and means the organized wholesale electricity market operated by the system operator. The businesses can not join Balancing Power Market that are unable to fulfill the order of take the load or throw the load. Taking the load; according to the instructions given by the system operator, a balancing unit sells energy to a system by increasing the production or reducing the consumption. Throwing the load; according to the instructions given by the system operator, a balancing unit sells energy to a system by decreasing the production or increasing the consumption.

Market participants who can participate to the Financial Market Reconciliation Center and those are:

- Production license holder,
- Auto producer license holder,
- Auto producer group license holders,
- Wholesale sale license holders,
- Retail sales license holders and participants need to check in to the Market Operator, in other words to the Financial Market Reconciliation Center.

4.2.2. Derivatives Products

Derivatives are the financial assets that price at the end of the maturity or within maturity, are determined by the price that is subject of the contracts. They do not give a proprietary right about related contract on the contrary of the stocks or securities. (Özen, 2008)

A derivatives product can be made on different assets. Those are can classify as below:

- Energy products (crude oil, oil, electricity, kerosene, coal etc).
- Agricultural products (wheat, barley, cotton, sugar, etc.).
- Financial assets (stocks, foreign currency, interest, treasury bonds, etc.).
- Animal products (Alive beef, pork, eggs, etc.)

Derivatives products can create one to one profit or loss positions by capital price changing without making investment as the same amount as capital. Market and credit risk management provides alternative opportunities. They increase market depth by providing liquidity. They reduce the risk by diversification of products. They divided into 4 as forward, futures, option and swap.

The Reasons for Choosing Derivatives Exchanges:

- There are 3 main reasons of choosing derivatives exchanges:
- Getting information about the price of the product in future
- Protection from the risk in investments that are made in spot market.
- Making speculation in order to gain.

4.2.2.1. Traded Term Instruments

Four types-term instruments in the world widely traded in the markets:

Option Contracts: Unlike forward and futures contracts, in options, agreements, the sides do not have equal conditions in meeting its obligations. The thing that is purchased and sold is the right of selling or buying of the asset in a future date, not the asset itself.

Futures Contracts: After the establishment of organized markets, futures contracts were traded on the stock exchanges. Primary elements of futures contracts are, in fact, are nothing more than standardized forward contracts. Futures contracts have given affect to forward contracts by eliminating a lot of disadvantages of it.

Forward Contracts: Looking at the historical development of the financial futures, forward contracts are made firstly. The lettre de faire contracts that are mentioned at the beginning of the chapter are example of forward contracts. Forward contracts, is the most primitive form of future contracts and the nature of the contracts are legally entitled. The essential elements of the contracts are determined by the buyer and seller mutually freely. This requirement is not mandatory in any shape of being valid contracts.

Swap Contracts: Another future contract is Swap Contracts. In these contracts, an asset or liability can be exchanged by the parties of the contracts. Parties collect receivables of opponent party or settle their obligation. Swap contracts give investors the opportunity to better management of the risks by giving the opportunity of accessing difficult markets. (Özen, 2008)

4.2.2.1.1. Energy Option Markets and the Operation of the Derivatives Exchange

Energy option market is very developed market. In NYMEX, firstly in 1986, crude oil options were processed. In 1987, oil option made in IPE. After this date, the option markets become widespread. (Erdoğan, 2006)

Options	Market	Options	Market
Crude-Oil	NYMEX	Gas Oil	IPE
Natural Gas	NYMEX	Natural Gas	NYMEX
Heating Fuel	NYMEX	Electric	Nord Pool

Figure 4: Important Option Markets which are traded on the world markets [5]

In stock market, buying-selling operations related to the contracts and other operations are made in electronic environment.

The main features of the operating systems that stock markets use are:

- The orders are delivered to the system using operation saloon or the methods that are clarified as remote access by the stock market.

- The operations are processed by matching transmitted orders' by their price and time priorities in electronic environment and they are based on an algorithm.

- The orders are entered as account based. Also, assurance and positions can be followed members based and/or account based.

- The existence of enough assurance, are controlled by trade institution in the operation time by the stock market. This control is not being made by the entry of the orders. The entry can be made to the system in the lack of necessary assurance, but the operations are not allowed. In time of matching the orders, the orders which do not have enough assurance are cancelled and removed from the system.

- The members can enter orders and execute their operations when they have the authorization.

- Orders, operations, assurances and positions can be followed in day. Also, in the end of day, the "trading books" and "stock market bulletin" are sent to the members.

4.2.2.2. The Usage Of Derivatives Products in Turkey

In Turkey, derivatives operations were made some intermediary institutions and banks in foreign markets. In 15 August 2001, after opening Istanbul Stock Foreign Currency (İstanbul Menkul Kıymetler Borsası-IMKB), financial futures associated with foreign currency have started. In 4 February 2005, after establishing of Izmir Derivatives Exchanges, the operations options in Turkish Derivatives Markets are increased.

Total transaction volume of Izmir Derivatives Exchanges-TURKDEX (Vadeli İşlem ve Opsiyon Borsası-VOB) that is established in 4 February 2005 was 2.919,48 million YTL in 2005. This transaction volume is about 7, 47% of the derivatives operations that are executed over the counter market. In TURKDEX, 75, 73% of the operations are consist of foreign-currency based, 22, 56% of the percent of the operations are index-based. In 2006, transaction volume is increased fastly and reached to 17.386,16 million.

This time, 38, 81% of the operations are foreign currency based, and 61, 02% of the operations are index-based. The ratio of the other operations is 0, 17%. In Izmir Derivatives Exchange, first year the share of the foreign currency based operations are pretty high, however in 2006 index based operations had the first place. (Özen, 2008)

4.2.2.2.1. Izmir Derivate Exchanges Installation Process

The first futures have been started at Istanbul Gold Exchange in 1997 in Turkey. Subsequently, futures contracts on foreign currency have been opened 2001 under the Istanbul Stock Foreign Currency after the transition to the floating exchange rate regime.

In 1999, in of Capital Markets Laws, an arrangement made is made about Futures Exchange. In 2001, in official gazette, regulations about the principles of Derivatives Exchanges Establishment and Operations are declared. This was followed by cabinet decision about Establishment of Derivates Exchange in 2001 and after that first private stock market is established in Turkey. In 2004, official authorization was taken from Stock Exchange Commission and in 2004, TURKDEX regulations are declared in Official Gazette. Eventually, the stock market put in service in 2005. With TURKDEX, future contracts with gold and foreign currency are embodied to that establishment. (Özen, 2008)

4.2.2.2.2. TURKDEX Structure and Processes

TURKDEX is established by Turkey’s leading financial organizations in Izmir. The management of TURKDEX consists of a president, a vice president and 8 board of manger that includes the president. Also, there is a board of supervisor that consists of 2 people.

The TURKDEX’s paid in capital is 9 Million TL. In figure 5, the partners and share rates can be seen. (Özen, 2008)

Name of Sharefolder	Stake/Portion
The Union of Chambers and Commodity Exchanges of Turkey (TOBB)	25%
Borsa İstanbul Inc. (BİAŞ)	18%
İzmir Mercantile Exchange (İTB)	17%
YapıKredi Bank Inc.	6%
Akbank Inc.	6%
Vakıf Investment Inc.	6%
Türkiye Garanti Bank Inc.	6%
İş Investment Inc.	6%
The Association of Capital Market Intermediary Institutions of Turkey	6%
Takasbank Inc.	3%
Industrial Development Bank Of Turkey (TSKB)	1%

Figure 5: The partners and share rates [4]

4.2.2.2.3. Derivatives Exchanges (TURKDEX) Principles

The principles are arranged by the notice.

TURKDEX session and trade hours can be seen in Figure 6.

T Day	08:45-09:15 : Period of Inactivity
	09:15-17:45 : Regular Session
	17:55 : The Listing of Settlement Prices and Publication of Margin Calls
	17:55 : The Beginning of the Process of Clearing
T+1 Day	14:30 : The End of Swap (Cash Reconciliation) 16:30 : The End of Swap (Cash Requirement-Physically Delivered Stockyard)
T+2 Day	16:30 : The End of Swap (Physically Delivered Futures Exchange)
Delivery Day	14:00 : The End of Swap (Physically Delivered Stockyard–Physical Delivery Requirement)

Figure 6: TURKDEX session and trade hours [4]

- In the period before session in TURKDEX (nonoperational period), system is open but execution of an operation or order entry is not possible. In this period, system can be connected by delegates. Also, debriefing and making block of order file can be done in this period and they can be sent to the system after normal session has started.
- The "valid orders until cancellation" or "dates" orders that are executed previous days can be fixed or cancelled.
- Between 09:30-17:10, there is a session that is called as normal session. This session is the session of execution of operations by auction according to time and price priorities.
- Last 10 minutes of the session is called as "closing interval".
- After ending of normal session, reconciliation prices are announced and orders with closing prices are matched with the system.
- After ending of normal session, those matched orders are included to the normal session operations. At 17:25, reconciliation prices that belong to operation day are declared. After that, margin calls that are associated with the member are declared in terminals.
- "Trade period" starts at 17:25 in T day and continues until 14:30 in T+1 day. The ones, who have not performed their obligations, become overdue. (Özen, 2008)

4.2.3. Bilateral Agreements

"A bilateral contract is any contract between a buyer and a seller for the purchase and sale of an electricity-related product at negotiated terms including duration, price, delivery location, times of performance, and any other terms which may be deemed applicable. An electricity-related product may be electric energy, capacity (including demand response), ancillary services or some combination of those." (Hausman, Hornby, Smith, 2008)

"*A purchase from the spot market provides supply for a period of up to one day, and involves no negotiation between the parties. In these RTO-administered markets all parties who wish to either sell electricity on the delivery day, or buy electricity on the delivery day, submit their price and quantity offers and bids. The entire market settles simultaneously based on the* *output of a computer model that selects the lowest priced resources (based on the owners' bids) needed to meet load, given transmission constraints, usually following an algorithm known as Locational Marginal Pricing (LMP). The resulting hourly locational market prices are determined by the price bid by the marginal supplier selected through this process."* (Hausman, Hornby, Smith, 2008)

The final alternative for retail providers to meet their obligations is through self-supply. It is this option that should, in theory, control the market power of bilateral contract sellers, as well as ultimately keep spot market prices for energy and capacity to cost-based levels. While this option has always been a primary means of procuring energy in regulated markets, it is far less common in deregulated markets. In fact, one of the primary goals of deregulation was to mitigate or eliminate the structural market power of generation in vertically integrated utilities in order to foster competition in this area. (Hausman, Hornby, Smith, 2008)

However, retail providers can still self-supply either generation or demand management resources in deregulated states. In most cases today, self-supply of demand management services is the least-cost resource option for retail providers. Unfortunately, numerous structural obstacles beyond the scope of this study have prevented the full implementation of this resource option. Whether the development of self-supply in the energy and capacity markets will ultimately reduce procurement costs for those products remains to be seen, but it does not appear to have done so to date. In regulated markets, self-supply and bilateral contracts are the primary instruments through which electricity is bought and sold. In these markets there is no organized multiparty electricity auction, so all transactions are on a bilateral basis. (Hausman, Hornby, Smith, 2008)

The value of bilateral contracts lies in their ability to provide willing buyers and willing sellers with a mechanism through which to craft a transaction that meets their specific needs in terms of quantity, price and duration. Because such contracts are negotiated in advance of the delivery period, each party has the option of not entering into the contract if it doesn't like the terms, of seeking another contracting partner, of engaging in self supply, or of waiting to transact in the spot market. The revenue and cost certainty associated with bilateral contracts presents a number of benefits to sellers and buyers in both the near-term and long-term, as will be discussed more fully later in this report. (Hausman, Hornby, Smith, 2008)

"Ranked roughly from near-term to longer-term, these benefits include (Hausman, Hornby, Smith, 2008):

- *Less volatile retail prices.*
- *Mitigation of market power.*
- *Support for development of new resources.*
- *More cost-effective, environmentally attractive resources in the long-term."*

Chapter 5

Trading Strategies in Energy Market

Energy trade is made by 3 ways in 3 different ways.

- By bilateral agreements
- Day-ahead planning
- Balancing power market

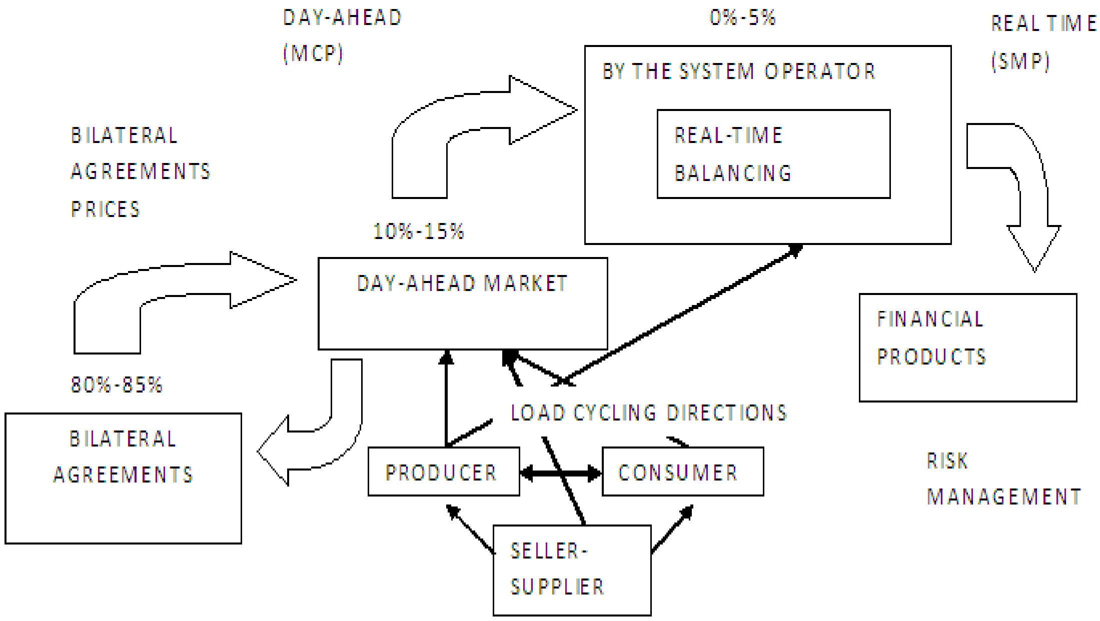


Figure 7: Electricity Market [15]

In figure 7, electricity market is summarized schematically. As it can be seen in the figure, 80-85% of the electricity trade is being made by bilateral agreements; the other volume is spread to the day-ahead planning and balancing power market. It is expected that day-ahead operations are for electricity trade, balancing power market operations are used for balancing electricity supply and demand.

Day-ahead planning and balancing power market are the markets that are operated under control of the Financial Market Reconciliation Center. In day-ahead planning, the operations that are outside of the bilateral agreements and the operations that is hyperergy according to the consumption assumptions are executed. In balancing power market, the operations that provide instant balancing are operated. Licensed participants carry out transactions. (Çetinkaya, Öztürk, 2011)

Licence Type	Community	Private
Production	5	232
Autoproducer	1	141
Whosale Trade	1	101
Retail Trade	13	8
Autoproducer Group	0	2
Organizel Industrial Zone Production	0	1
Total	20	485

Figure 8: The number of Financial Market Reconciliation Center participant number according to the their license type [14]

5.1. Day-Ahead Planning

Day-ahead planning system is the market that is under Turkish Electricity Transmission Incorporation-Financial Market Reconciliation Center. This market, which is organized by Electricity Market Balancing and Settlement Regulation under year of 2009, makes real of those aims:

- By giving a chance to the market participants in addition to bilateral agreements purchasing and selling of energy, production and/or consumption
- Creating a balanced system to the system operator.
- Determining electricity energy price.

In day-ahead planning operations executed daily and hourly. Although Financial Market Reconciliation Center obliges the participants to participate the day-ahead planning, the market participants have to present their all available capacities.

The plan that is made for every hour of next day in day-ahead planning has those processes:

- Daily production Plan, central based, reported every day until 11:30.
- Bilateral agreements are entered the system by production system and confirmed by consumption until 11.30 everyday
- Consumption estimations reported by market participants until 11:30
- Market participants report the offers of buying from system and selling to system according to their buying from system and selling to the system capacities relatively.
- Reported production plans, consumption estimations and system operator determine the system direction.
- Day-ahead price is determined according to offers that evaluated by system direction.
- Take Load (YAL) or Bleed off (YAT) are transmitted to the market participants by system operator.
- Payments that are associated with directions are made daily.
- Day -ahead operations are completed by 16.00.
- From 2011, in day-ahead planning, it is been expected that secure structure has to start to activity.
- In order to execute an operation in day-ahead planning with starting of secure structure, market participants need to have enough security in Takasbank that is the place for central conciliation. (Çetinkaya E, 2011)

Example of Day-Ahead Market Sales

Day-Ahead Price Determination System:

- Declared production plans, consumption estimation and system runner determine the direction of the system.

Total Production Schedule (MWh)	Total Comsuption Schedule (MWh)	Production-Comsuption (MWh)	Aspect of the system	Mainly Direction of the Accepted Birds	Total Production (MWh)	Total Comsuption (MWh)
16.000	17.000	-1.000	gap of energy	Sales to system	-6.333	-14.833
10.000	10.000	0	balance	Balance	-3.333	-8.333
12.000	11.500	500	lots of energy	Purchasing from system	-3.500	-9.250

Figure 9: An example of determining system direction [35]

- System retail or buying bids are evaluated according to system direction.
- Retail bids are evaluated for the system, if there have a deficit.
- Buying bids are evaluated for the system, if there have a surplus.
- Retail bids are ordered increasingly.
- Buying bids are ordered decreasingly.

The list of buying and selling offers to system:

Hourly Selling Offers to System for 8:00 a.m.		
Offer Amount (MWh)	**Offer Price (TL/MWh)**	**Partial Acceptance**
100	70	YES
100	70	YES
100	71	NO
100	74	YES
100	79	NO
100	80	YES
100	83	NO
100	87	YES
100	96	NO
180	97	NO
150	99	YES
200	100	YES
...	...	...

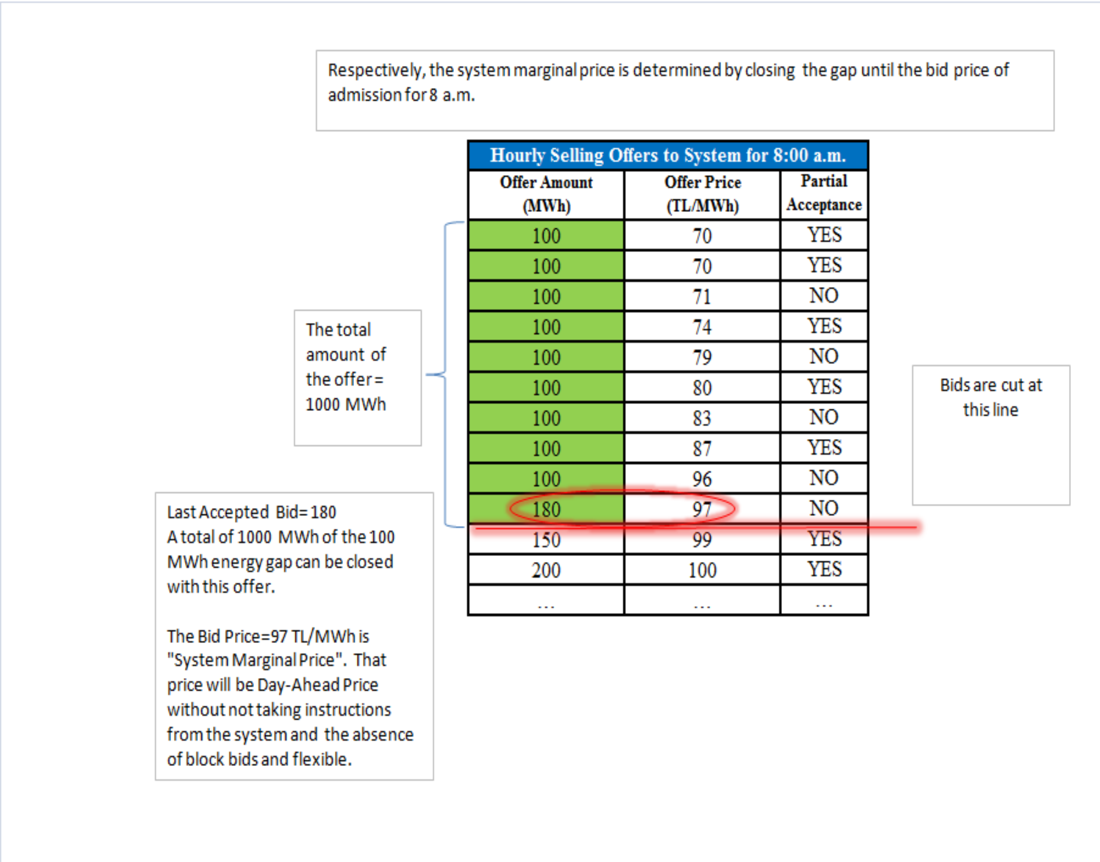
Figure 10: Hourly Selling Offers to System for 8 a.m. [35]

Hourly Purchasing Offers to System for 9:00 a.m.		
Offer Amount (MWh)	**Offer Price (TL/MWh)**	**Partial Acceptance**
76	50	NO
43	50	NO
89	48	YES
20	47	YES
67	46	NO
5	39	YES
16	37	NO
94	36	YES
107	36	YES
8	34	NO
56	30	NO
190	30	YES
...	...	...

Figure 11: Hourly Purchasing Offers to System for 9 a.m. [35]

- The last bid which meets the surplus/deficit of the system becomes the Price of Day-Ahead System (SGÖF).

- Then Take Load (YAL) or Bleed off (YAT) directions are formed regarding partially acceptability and transfer constraint.



Hourly Selling Offers to System for 8:00 a.m.		
Offer Amount (MWh)	Offer Price (TL/MWh)	Partial Acceptance
100	70	YES
100	70	YES
100	71	NO
100	74	YES
100	79	NO
100	80	YES
100	83	NO
100	87	YES
100	96	NO
180	97	NO
150	99	YES
200	100	YES
...	...	...

Figure 12: Day-Ahead Price Determination System [35]

5.2. Options

Electric maturity operation contracts are processing in a lot of stock market as cash and physical conventional. Those stock markets differ from each other by stocks and bonds markets, derivatives product stock markets and energy stock markets. In foreign stock markets, electric maturity operation contracts are processed in cash in stocks and bonds markets and derivatives product stock markets. However in energy stock markets, it is known that electric maturity operation contracts are processed both in cash and physical conventional.

In foreign stock markets, the maturity dates of cash conventional electric maturity operation contracts can be weekly, quarterly and yearly. Those contracts can differ according to their time intervals as Base Load, Peak Load and Off-Peak Load. Cash conventional electric maturity operation contracts in foreign stock markets have similar features with the processed products.

Monetary Agreement Electricity Forward Transaction Agreements

- Base Load
- Peak Load
- Off-Peak Load

Physical Delivery Electricity Forward Transaction Agreements

- Base Load
- Peak Load

Base Load explains the minimum force that will be produced/ consumed in a time unit. Base load forward transaction agreements involve 24 hours since they reflect the minimum force of producing/ consuming for all-day.

Peak Load explains the maximum force that will be produced/ consumed in a time unit. The definition of peak load is changeable according to countries and stock markets. Usually it defines the day between 8.00 am and 8.00 pm except from bank holiday and weekends. Energy Trade Association defines so for Turkish electricity market.

Off-Peak Load involves the time out of peak load.

Contract:	***Base Load Electricity Contract***
Underlying asset:	Underlying asset is the simple arithmetic mean calculated by System Day-Ahead Prices (SGÖF) for each hour of due month. Passing from Day-Ahead Planning to Day-Ahead Market, underlying asset will be the simple arithmetic mean that

	calculated from Unrestricted Market Barter Prices (KPTF) by TEİAŞ for every hour.
Agreement Magnitude:	Number of Hours in Due Month x 1MWh. Number of Days in Due Month x 24. Agreement magnitude varies from the days of due month to winter/summer time.
Price Quotation:	The Turkish Lira value of electricity energy of 1MWh is written 2-digit decimal. (e.g.: 121, 25)
Minimum Price Step:	0, 01
Agreement:	Base Load Electricity Contract
Due Months:	All months of the year (Agreements that simultaneously at the month and the next three due months are transacted.)
Accordance Model:	Accordance is done with monetary accordance at the end of due date.
Daily Accordance Price:	Same as other agreements those are processed.
Final Accordance Price:	Passing from Day-Ahead Planning to Day-Ahead Market, final accordance price will be the simple arithmetic mean that calculated from Unrestricted Market Barter Prices by TEİAŞ for every hour. Expiry date accordance price is rounded up to the closest price tag after determined with above methods.
Last Trading Day:	The last labor day of due month. If the last day is half-day because of national markets' bank holiday, the last transaction

	day is the previous day.
Expiry Date:	The last day of every due month. If the last day of due month is not a labor day, the due date of agreement is the next Labor Day. If the last day is half-day because of national markets' bank holiday, the last transaction day is the next day.
Initial Margin:	12.000 Turkish Liras
Daily Price Movement Limit:	+/- 10% of the base price
Limit Position:	Absolute limit position is 2.000; rational limit position is 10 %.

Figure 13: Base Load Electricity Contract Example [14]

Examples of Options Trading

Protetion Example-1

There is a power plant.

It is estimated for this power plant to produce about 10 MW in January, February and March.

Then the power plant demands a protection against the risk of price reduction.

TURKDEX- the market prices of Base Load Electricity Agreement:

January: 118 TL/ MWh
February: 110 TL/ MWh
March: 102 TL/ MWh

Power plant takes 10 short positions in January, February and March agreements.

The average retail price of the power plant will be 110TL/ MWh no matter what spot price becomes. (Çetinkaya, 2011)

When day-ahead price averages are:

January: 124 TL/ MWh

February: 108 TL/ MWh

March: 98 TL/ MWh

	January	February	March	**TOTAL**
Option Sale Price	118	110	102	110
Spot Sale Price	124	106	95	108,33
Option Market Profit/Sale	-6	4	7	1,67
Earned Sale Price	118	110	102	110

Figure 14: Profit or loss status for 1MWh [35]

Protection Example-2

Production power plant

The expenditure of power plant's production is 80 TL/ MWh averagely.

Power plant plans to sell 20 MWh of electricity in October.

Agreement price for October is 76 TL/ MWh.

Power plant sells 20 agreement in October when t=0.

The average retail price of the power plant will be 76 TL/ MWh no matter what spot price becomes. (Çetinkaya, 2011)

Protection Example- 3

Wholesale- Retail Firm

Wholesale retail firm makes a bargain with an in order to sell electricity in October.

Wholesale retail firm expects A to consume about 10 MWh in October.

Wholesale retail firm makes a bargain with A to sell electricity to A for 78 TL/ MWh.

Price of agreement for October is 76 TL/ MWh.

Wholesale retail firm gets 10 agreement in October when t=0.

The buying price of wholesale retail firm will be 76 TL/ MWh no matter what spot price becomes. (Çetinkaya, 2011)

5.3. Bilateral Agreements

Bilateral Agreements are associated with private law conditions, but market participants can make deals freely. The amounts are stated to the Turkish Electricity Transmission Incorporation; however price information can keep hidden from this foundation. It is known that 80% of the bilateral agreements are between Electricity Generation Incorporation and marketing companies.

In electricity market, which advances through legal rules, they are accepted as "Free Consumer" whose energy consumption is more than 100,000 KWh since 2010. According to this regulation, free consumers can buy energy from any of those have license and the right to sell electricity energy in the market.

To look at the general running of the system, Supplier Company determines the discount rate of the free consumers who demand and prepares the optimum bid evaluating the subscription structure and retrograde energy consumption profiles of the last 1 year. Firstly, it is quite important for the Supplier Company and free consumer to agree on energy unite price. After the bid stage, the conditions of obligatory bilateral agreement, which is actually Energy Selling Agreement, are determined by Supplier Company and free consumer by negotiating. Agreement duration and avoid conditions, energy unite price and security deposit are the very important points that free consumer has to pay a special attention.

Moreover, there is a procedure that free consumer has to obey in order to buy energy from any of supplier companies. Right after this procedure, Supplier Company starts the providing process by recording in PMUM.

Pursuant to relevant by-law the right to alter the supplier is always substantial. The free consumer can choose another supplier or can supply energy from Distribution Company again if they have the right to notification of avoid in Energy Selling Agreement.

Chapter 6

Model Development and Formulation

Our operational aim in this research is to get the maximum profit by selling electricity in spot market, derivatives market and bilateral agreements. Therefore, we should base our general model into 3 different parts. We have created formulations to sell owned products firstly at spot market, then at derivatives market and at last by bilateral agreements. After, we obtain the optimum result for each sell independently, our chief object; generating scenarios until we get the maximum profit. Necessary notations for formulation are given at List of Notations part.

6.1. Energy Sales through Options

As it is known, the price of electricity was determined as income would be above the expenditure. This situation resulted to that monopole became less cautious and spent more since the enterprising risks transferred from the producer to customer. After electricity reforms, we can state that enterprising risks re-transferred from customer to producer. On the other hand, the new market structure after reengineering movement of electricity sector led to more waving in electricity prices and this creates a risk not only for producers but also for consumers. The management of risks is implemented by electricity marketing in the new market structure after reengineering movement.

The participants of electricity market use instruments of electricity marketing and implement the transaction of a determined price of determined electricity in a forward date. Thus they protect themselves against the risks such as price waving or not to find any buyers between agreement bargain date and physical buying and selling.

Moreover, traders, who transact in order to get the efficiency by profiting from the changes in electricity prices and differences among markets and supply liquidity to the market, also take a place in derivatives electricity marketing.

To explain with a more detailed example, in September there is a contract that represents a consumption and production that is 1 Megawatt per hour. In November, the average becomes 120 liras, which means that the marketing supposes that 1 Megawatt will cost 120 liras. If the November's average becomes 115 liras, the 5 liras will be a profit for seller and the buyer will lose. So, if A sells and B buys and the price is 120 lira, we take the difference between the prices of A and B and the average prices of Novembers' electricity. Simply, we create the chance for the buyer or the seller to get the profit or loss from the difference of Spot market's average and stock market's forward prices. (Saglam, 2012)

Shortly, if especially the physical delivery is implemented by stock market, the electricity producer can determine the price of electricity for different months of the year already. This means that businessman or the producer can put a price tag on and calculate the expenditures of the next 6 month or 1 year in a better way. After summarizing options advantages, we can explain how we create our options formulation.

First of all, we generate a model to sell of electricity option at derivatives market. Notations about this are given at the List of Notations part. The general purpose of objective function is to get the maximum profit.

Objective function:

$$\max E(R_1) = \frac{1}{K}\left[\sum_{t=1}^{m*h} Q_t^i P_t^k - C\left(Q_t^i\right) + O^i\left(x - \bar{P}_t^k\right)P_r\left(x > \bar{P}_t^k\right) - O^i\left(\bar{P}_t^k - x\right)P_r\left(x < \bar{P}_t^k\right)\right] \qquad (1)$$

Constraints:

$$c\left(Q_1^i\right) = \alpha + bQ_1^i + g\left(Q_1^i\right)^2 \qquad (2)$$

$$Q_1^i \leq Q_{cap} \qquad (3)$$

$$Pr\left(x < \bar{P}_t^k\right) = \int_x^{\infty} f_{\bar{P}_t^k}\ \left(P_t^k\right) dP_t^k = 1 - F\ \bar{P}_t^k(x) \tag{4}$$

$$O^i = \frac{Q_1^i}{0{,}1} \tag{5}$$

Eq. (1) shows the objective function which we create to obtain the maximum profit from option trade. Generally, formula consists of 3 main parts. The first part of formula's aim to find revenue. It is obtained by multiplying the power produced and spot market price at time t and decreasing the prime cost. When the process proceeds and if the agreed market price is higher than spot market price, then the 2nd part of formula processes. It is consist of 3 parts inside. The number of options which we have sold, subtraction of spot market price from agreed price and multiplication of the probability of option price which means strike price is higher than the spot market price. Finally, the result shows us the cost for buyer. The third part of formula is used if the strike price is lower than the spot market price of the current process. It is also consist of 3 parts like above formula. The number of sold options, subtraction of agreed price from market price and the multiplication of the probability of option price which means strike price is lower than the spot market price. Briefly, the aim estimates the loss that is caused by being option price which is obtained from sells is lower than the market price. Finally, we reach option revenue dividing by result and K which means number of power scenario.

Eq. (2) is the first of our limitations. It shows that total price criterion while our electricity sells process in 3 pieces.

Eq. (3) is the second of our limitations. It shows that the capacity of sold electricity by options should be lower than the total amount of electricity which we have sold.

Eq. (4) is the third of our limitations. Basically this equation shows the probability of with how much percent; it will be lower than the strike price.

Eq. (5) is the last of our limitations for this options model. It is operational aim to designate how many option I have sold in that sale by dividing power produced at options and 0, 1 MW. (1 unit sell in electricity sells is equal to 0, 1 MW.)

6.2. Energy Sales in Bilateral Contracts

Energy selling agreements determine the general framework of the agreements of energy selling in market. According to this, besides re-selling energy and capacity, energy selling agreements state to sell energy and/or capacity to free customers who use energy as consequential consumption. At the first probability, it is being talked an agreement between supplier and free customer. In this situation, on one side of the agreement auto- producers and groups, wholesale retail company, retail company and retail selling license owner company take place as “supplier” while on the other hand customers who consume more energy than Energy Market Regulatory Authority determines. At the second probability, Producer Company or wholesale retail license Owner Company take a place on one side and retail selling license owner on other side.

In short, thanks to bilateral agreements an electricity production power plant is able to know how much to sell the electricity. On the first stage, company looks for and finds themselves, then different agreements are made according to the market price. After talking about bilateral agreements advantages, we can explain how we create our bilateral agreement formulation.

First of all, we build up an objective function for electricity sells by bilateral agreements. Necessary notations are given at the List of Notations part. The general purpose of objective function which we created is gaining the maximum profit from electricity production by selling with bilateral agreements.

Objective function:

$$\max E\,(R_2) = \sum_{t=1}^{m*h} Q_2^i\, P_{constant} - c\left(Q_2^i\right) \qquad (1)$$

Constraints:

$$c\left(Q_2^i\right) = a + bQ_2^i + g\left(Q_2^i\right)^2 \qquad (2)$$

$$Q_2^i \leq Q_{cap} \qquad (3)$$

Eq. (1) is obtained by subtracting the total cost from multiplication of the amount of sold electricity and constant electricity cost.

Eq. (2) is the first of our limitations. It shows the criterion of total cost because of electricity sells occurs into 3 parts.

Eq. (3) is the second of our limitations. It shows that capacity of electricity sold by bilateral agreements should be lower than the capacity of total amount of electricity which we have sold.

6.3. Energy Sales in Spot Market

Day-ahead market briefly is the market that plots the production and consumption of electricity one day before. Day-ahead market can be described as a platform on which they bid the buying- selling prices of the next day's each hour. Also it can be summarized as the market that crosses the supply/demand curve to determine market barter price.

Usually, in the structure of day-ahead market the process of price evolution is formed by participation of both supply and demand sides and the bid price that is determined by regarding the marginal expenditure of the production foundation, which supplies to meet the hourly demand, is forming the price that is paid to all producers. (Saglam, 2012) Briefly, talking about spot market advantages, we can explain how we create our spot market formulation.

First of all, we build up an objective function for electricity sells at spot market. Necessary notations are given at the List of Notations part. The general purpose of objective function which we created is gaining the maximum profit from electricity production by selling with spot market.

Objective function:

$$\max E(R_3) = \frac{1}{K}\left[\sum_{t=1}^{m*h} Q_3^i \, P_t^k - c\left(Q_3^i\right)\right] \qquad (1)$$

Constraints:

$$c(Q_3^i) = a + bQ_3^i + g\,(Q_3^i)^2 \tag{2}$$

$$Q_3^i \le Q_{cap} \tag{3}$$

$$Q_3^i = \begin{Bmatrix} Q_3^i & \quad if \quad & P_t^k \ge b + 2gQ_3^i \\ O & & otherwise \end{Bmatrix} \tag{4}$$

Eq. (1) is obtained by subtracting the total cost from multiplication of the amount of electricity which will be sold and spot market price at time t and dividing by K.

Eq. (2) is the first of our limitations. It shows the criterion of total cost because of electricity sells occurs into 3 parts.

Eq. (3) is the second of our limitations. It shows that the capacity of electricity which we have sold at spot market should be lower than the capacity of the total amount of electricity which we have sold.

Eq. (4) this equation which is the last of our limitations occurs if the given offer is lower than the spot market price at time t. It shows that electricity sell will occurs. Otherwise, electricity sell would not occur.

Chapter 7

Solution Approach

Main inputs of the model are generator data belongs to Soma electricity power plant's capacity values used in our model and market prices which we create on the basis of the data of April 2011 electricity spot market prices at PMUM.

It is needed 4 important inputs to get the most efficient solution. We reach the revenues using formulations those are made in Model Development section with 3 market values. We get Total Revenue Table at the end of the 100 solutions. As it is known, the model is founded for getting the most efficient electricity retail way in the base of 3 markets. Also, if we analyze the results of the model, we will get the most efficient capacity distribution of the 100 scenarios examination.

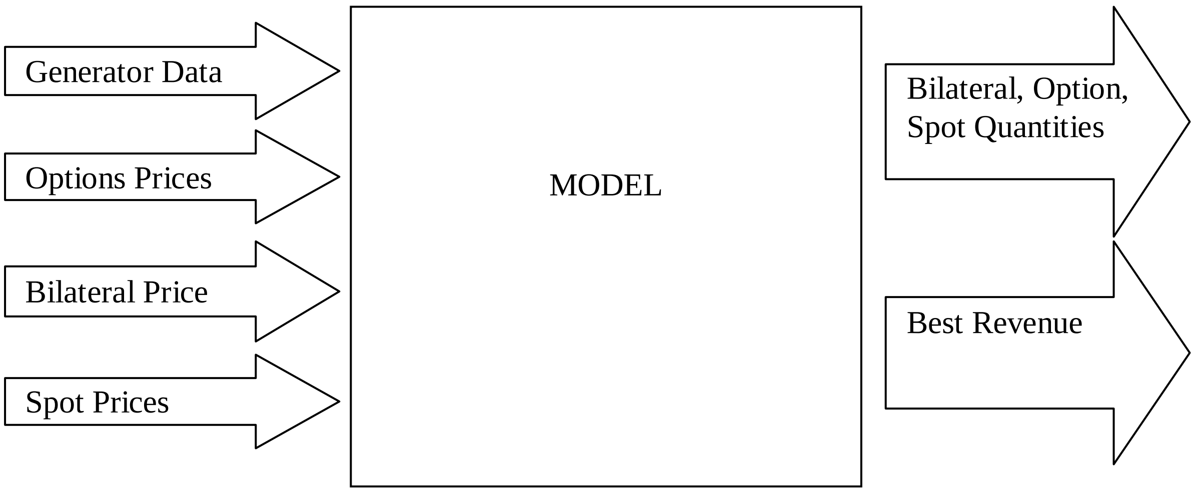
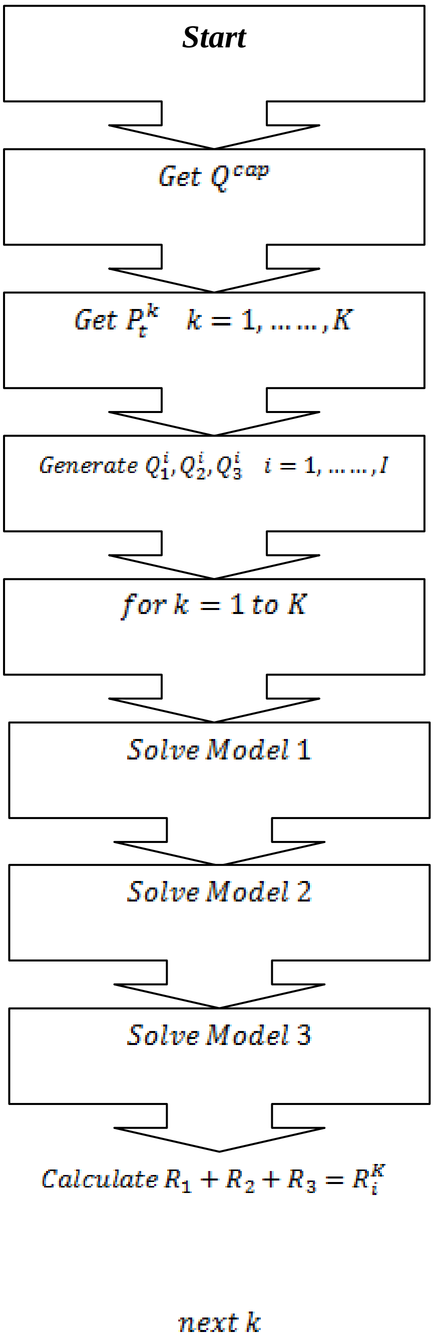


Figure 15: Model Inputs and Outputs

7.1. Model Data Inputs and Outputs

Making up the Excel model for reaching the optimum result, we took the electricity Option strike price of April's from TURKDEX and the bilateral agreement price of April's from PMUM and April's 720 hours System Marginal Price which is determined from PMUM for as our base. These data are run for each scenarios using Excel-Macros base and succeeded. Panoramic view is below:



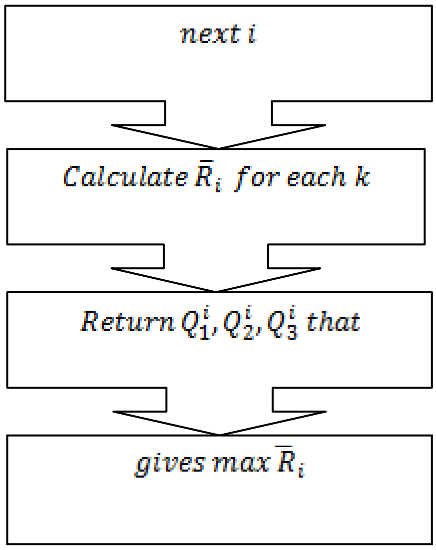


Figure 16: General Flow Diagram

Firstly, the capacity values of Soma Power Plant is handed for managing the solution. The 2nd step is to build 100 price scenarios in consideration of the data from PMUM. In addition to this, our 1000 MWh electricity power is produced randomly in manner of distributing to 3 electricity markets. At the Model Development section, we make formulations and price capacity distribution scenarios up and for this we calculate cost, revenue and profit values and build 100-100 matrix tables. We get 10,000 results for each scenario with Visual Basic Code writing in Excel-Macros base. The capacity values of the maximum efficiency, calculated with solution that we improved are written on Model homepage.

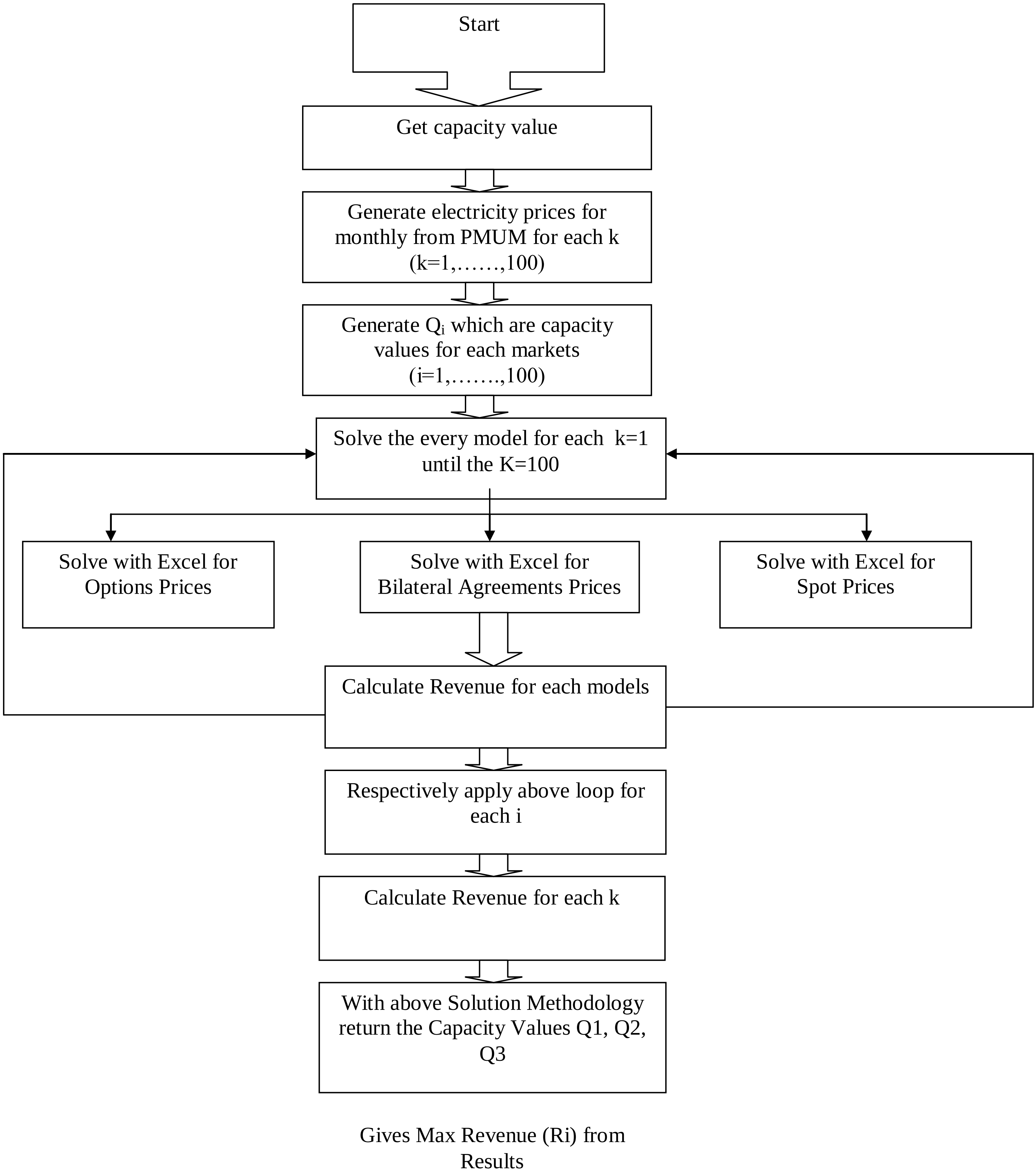


Figure 17: Solution Methodology for Modeling Energy Trader

Chapter 8

Numerical Results

In this chapter, settlements those are related to our working model will be examined. The chapters, those are till the main result in Excel, will be analyzed in subtitles detailed. The model, which is for finding the most efficient capacity distribution in 100 scenarios, gave us the optimum results by taking monthly data and prices those we produced in Excel as a base.

8.1. Model Section

Firstly, we made up the capacity values of the coal power plant that we would produce and sell electricity. Soma power plant generator unit characteristics values are the base of this thesis. Soma Coal Power Plant gained currency in 1953 by founding the power plant in spite of being known the coal existence in Soma since 1913. Thus, Soma Thermal Power Plant of 2x22 MW was founded in 1953. Between 1953 and 2005 140,297,371 tons of coal is burnt and 111,584,844,680 KWh of electricity is produced. The Soma Coal Plant is located in the west of Turkey and has a capacity of 1000 MW. (Kurban, Başaran, 2007)

Table 8.1.1: Generator unit characteristics [11]

	Soma
a	10268
b	12.4464
g	0.0336
Capacity (MW)	1000

The next table shows that Bilateral Agreement value is added to Excel by taking the price of PMUM in April 2011 as a base, as well.

Option Price and Strike Price are placed to the model by again using April 2011 prices. Options section is changing according to 100 different capacity scenarios which will be explained in Power section.

Table 8.1.2: Bilateral Agreement Price, Strike Price, Options, Options Price Schedule

Bilateral Price	85
stdev	10
Option price	1200
Options	7350
Strike price	90

Price and power scenarios are of 100 different scenarios in the below table. We will reach to different average prices. One of the major factors is average price and this will give us the maximum results of each scenario in order to reach the optimum result.

Table 8.1.3: Power and Price Scenarios

Price Scenario	1
Power Scenario	85
Average price	85,53262

We get the profits calculated for each Power and Price scenario by running the 10,000 scenarios those are built in Excel base for 3 markets in another table. For this, we use the formulations those we came up with in background of Model Development section. We distributed retail capacities those are determined for 3 markets' scenarios from Power section. After calculating and stating incomes of transactions for each market with Revenue, we calculated the expenditures of electricity that is produced with cost formulas. Only one transaction about the Options section is done in Probability section. If the strike price is higher than average spot price for the options, as we stated in Model Development building and telling the formula, electricity retail does not come true. Thus, we should calculate the probabilities.

Table 8.1.4: Options, Spot, Bilateral Agreements Revenues

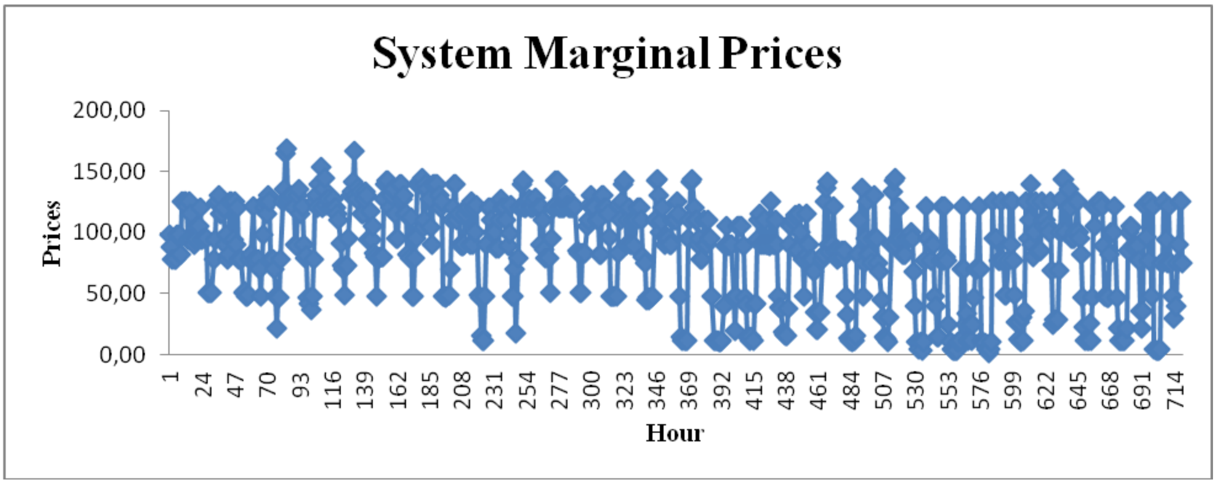
		Value	Revenue	Cost	Probability	Profit
Option	Q1	735	62866,48	27299,66	0,672467906	68402,06
Bilateral	Q2	135	11475	2292,624		9182,376
Spot	Q3	130	12361,56	2185,872		10175,68
Total		1000	86703,03	31778,16	0,672467906	77492,12

8.2. Prices Section

8.2.1. SMF Values

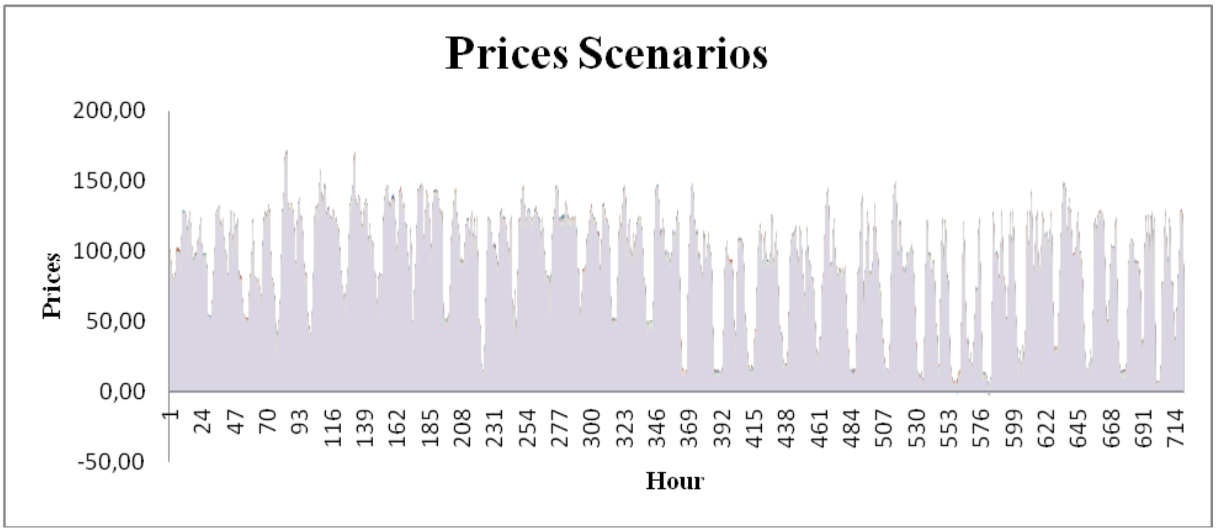
We have stated that we used the data that determined for April 2011's 720 hours by PMUM. The distribution of those prices is at the chart.

Table 8.2.1: The data of System Day-Ahead Values of April's 720 hours



We built price scenarios taking the system day-ahead prices as a base in Prices section for transacting in order to making different scenarios after Model Development section, which is the base of model running in Excel base. Finding the average of 100 price scenarios of 720 hours, we determined electricity retail price, which is our goal. The chart below shows the distribution of these scenarios.

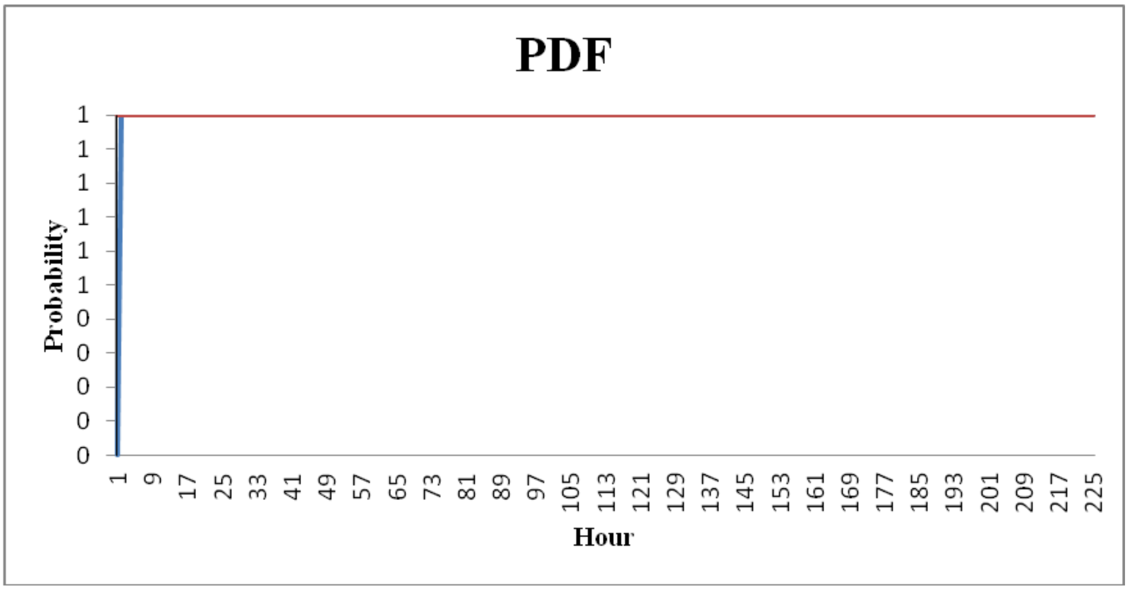
Table 8.2.2: Prices Scenarios



8.3. Options Section

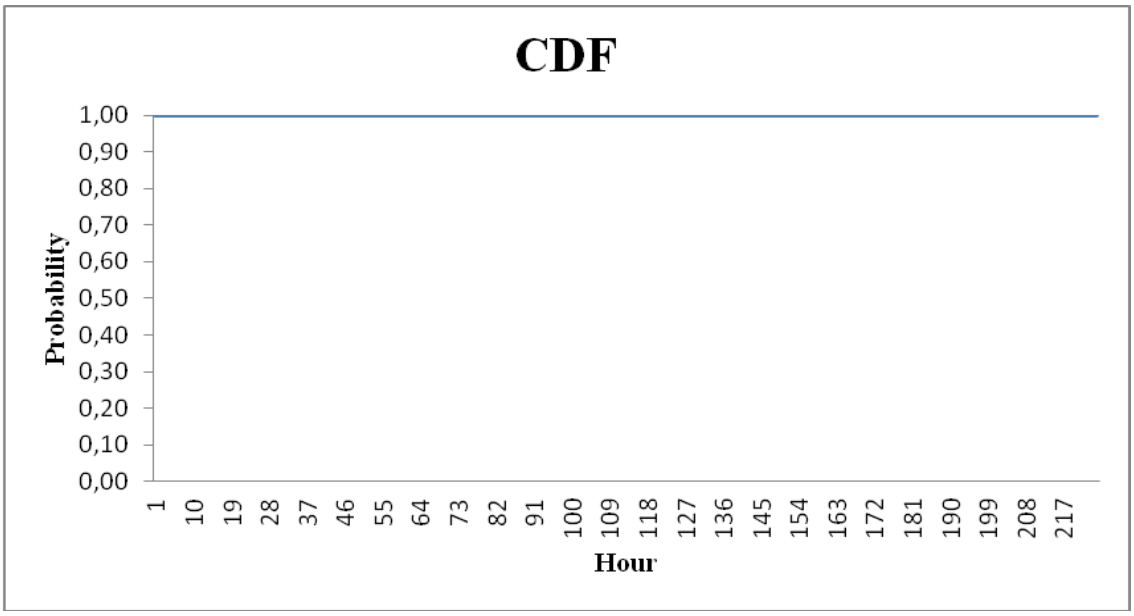
The reason why we built this section is to find whether strike price is lower than spot market price or not by using Options formulation that we developed in Model Development section. For this, we need cumulative distributions. In Model Development section, we had developed formulas and by using them we found probability distributions. The chart below shows the distributions those we found.

Table 8.3.1: *PDF Values*



After finding probability distributions by using formulas, we reached CDF values. And this shows us that if the strike price is lower than average spot price, we will transact the retail; contrary to this if strike price is higher than spot market price we will lose when we transact the retail. The CDF distributions of this section are prone to normal distributions. Thus, the average value is 100, standard deviation is 5. The chart below shows the distributions of calculated CDF values.

Table 8.3.2: CDF Values

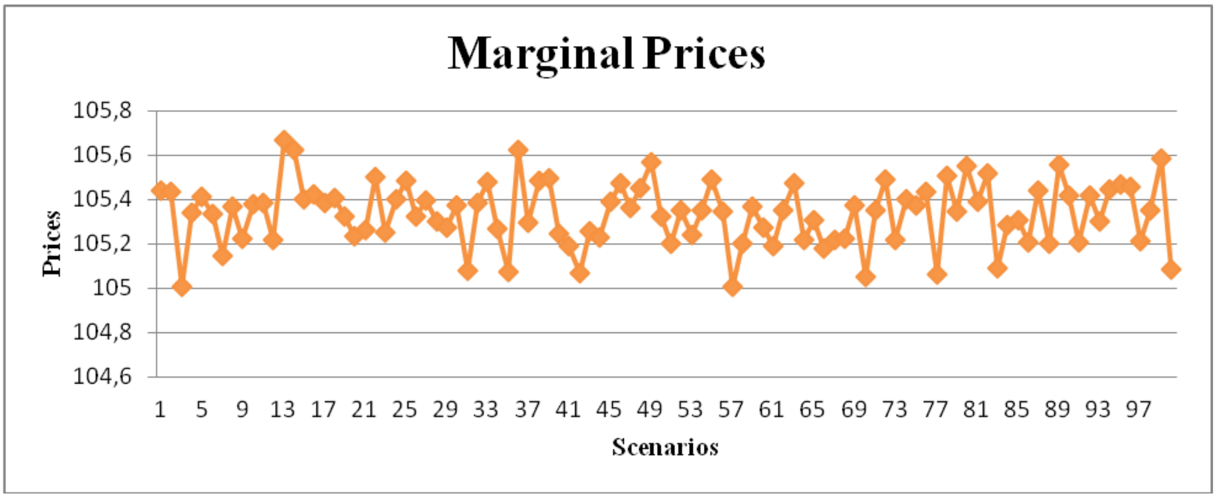


8.4. Marginal Section

Marginal values are for spot market prices, because option prices and bilateral agreement prices are fixed values. Since spot market numbers are changeable and its marginal value is calculated for every transaction. If the price is higher than expenditure, retail is come true and its value is 0 based upon the formula. In contrast, if the price is lower than the expenditure then we produce electricity and its value is 1 based upon the formula. If the price is higher than the expenditure we do not sell electricity because this means that we will lose money from our energy trading.

The main point of this section is that marginal price affects optimum result directly because it is used in calculating spot market income. After calculating whether retail will be transacted for each scenario or not, firstly, 720 hours of data is multiplied and added to SMP data for the 1st scenario. All scenarios are applied this transaction orderly. This number is divided to the average of the 1st scenarios done and undone retails, and thus, spot retail price is found. This side means marginal off value in Model section. By means of Excel-Macros, this value is written in each scenario's Model page as in the above table.

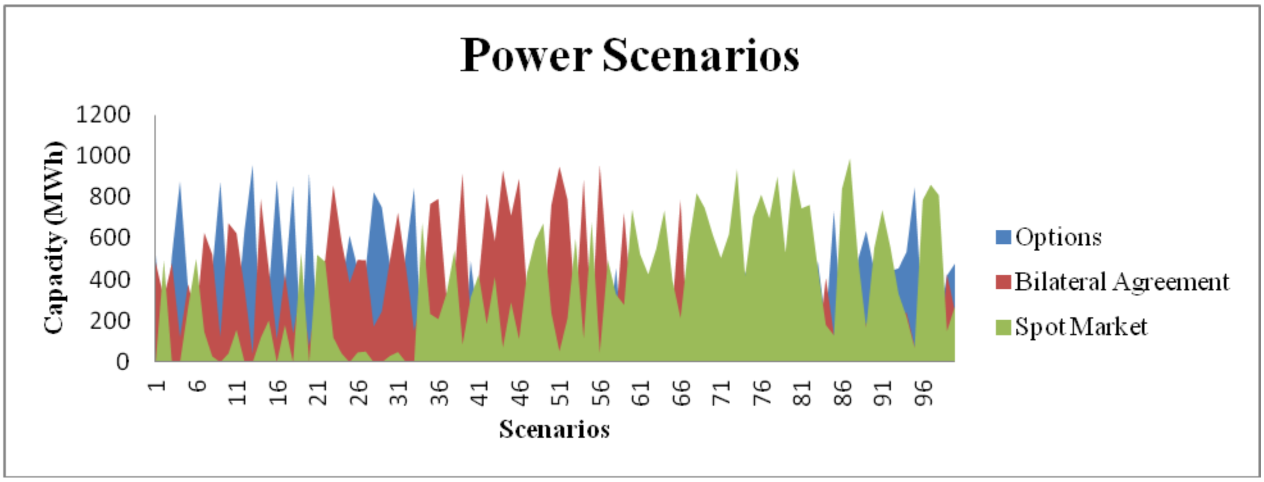
Table 8.4.1: Values of marginal off for each 100 of scenarios



8.5. Power Section

In this section, we get 100 scenarios with Excel formulas without exceeding our capacity, which is 1000 MWh. In every scenario, 1000 MWh is distributed to 3 different markets. The distributions of the data those we got is the chart below.

Table 8.5.1: The distributions of power scenarios those are built for 100 different scenarios

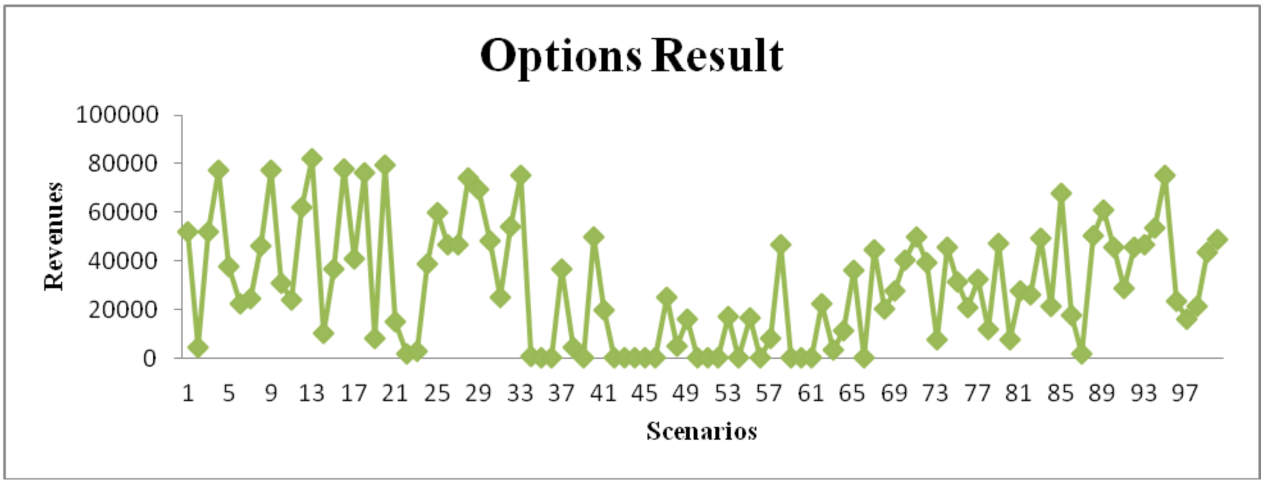


8.6. Results Section

8.6.1. Options Schedule

We calculated and wrote to the table every profit for 10,000 different situations by using codes those we wrote on Excel-Macros and using option profit formulas in Model section, as a result of 100 different scenarios those we got in Price and Power sections. The average revenue values are in the chart below.

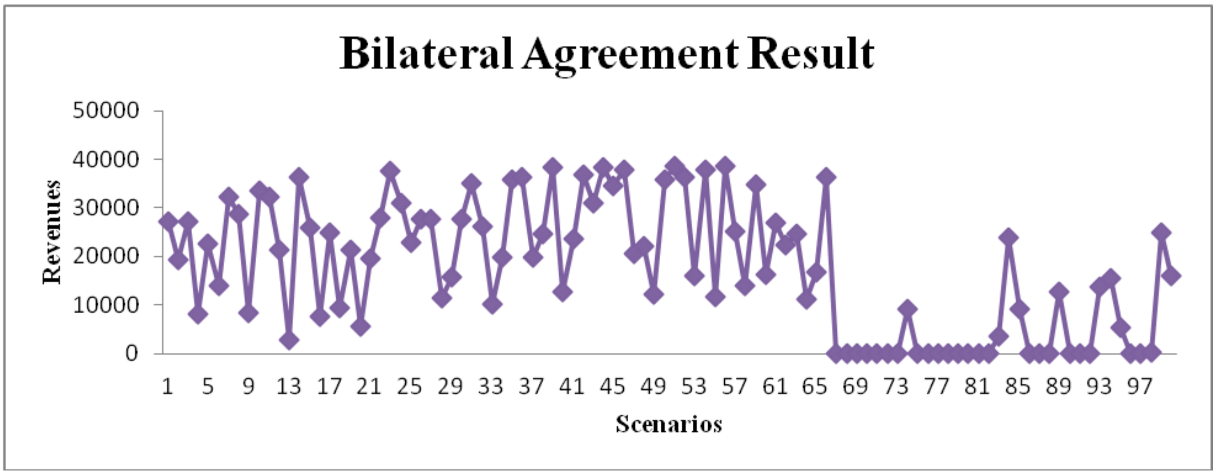
Table 8.6.1: The Average Revenue Values



8.6.2. Bilateral Agreement Schedule

We calculated and wrote to the table every profit for 10,000 different situations by using codes those we wrote on Excel-Macros and using bilateral agreements profit formulas, in Model section, as a result of 100 different scenarios those we got in Price and Power sections. The average revenue values are in the chart below.

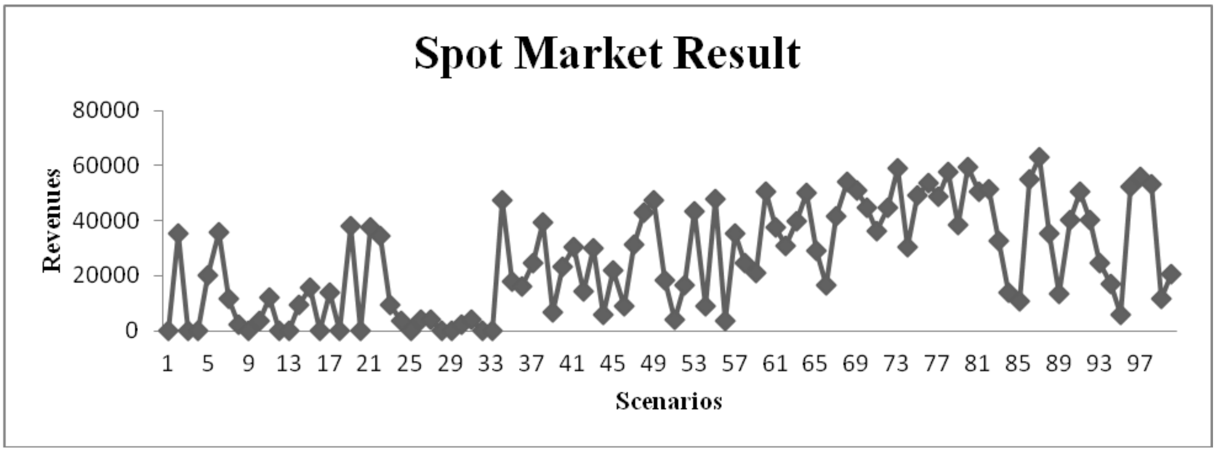
Table 8.6.2: The Average Revenue Values



8.6.3. Spot Market Schedule

We calculated and wrote to the table every profit for 10,000 different situations by using codes those we wrote on Excel-Macros and using spot market profit formulas in Model section, as a result of 100 different scenarios those we got in Price and Power sections. The average revenue values are in the chart below.

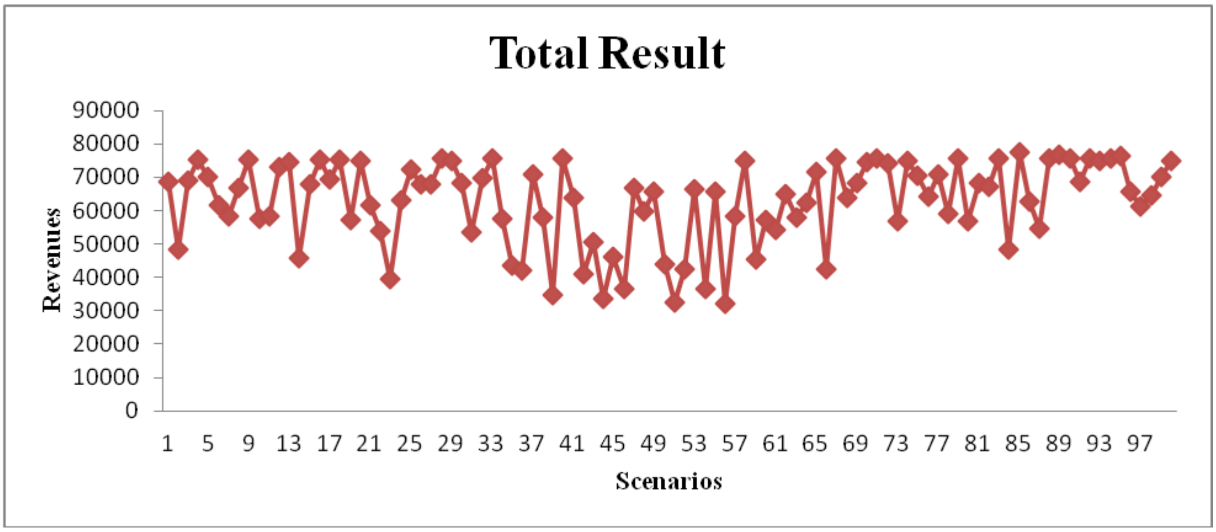
Table 8.6.3: The Average Revenue Values



8.6.4. Total Schedule

We calculated and wrote to the table every profit for 10,000 different situations by using codes those we wrote on Excel-Macros and using total of profit formulas in Model section, as a result of 100 different scenarios those we got in Price and Power sections. The average revenue values are in the chart below.

Table 8.6.4: The Average Revenue Values



8.6.5. Best Revenue and Best Scenario

To summarize step-by-step all transactions for reaching the optimum result and to the main table which generates 10,000 different scenarios in order to reach the most efficient retail:

MODEL

- We calculated the marginal value using Soma Power plant's generator characteristic units and expenditure formula.
- We added to Excel the price of Bilateral Agreement of April 2011 from the PMUM.
- We placed to the model the option price and strike price of April 2011.

MODEL

- Price ve power scenarios are built up from 100 scenarios.
- We reached different average prices and marginal off values for each scenarios.

MODEL

- We prepared profits for every power and prices scenarios by working 10,000 Excel scenarios for each 3 kinds of market.
- We got the distribution of retail capacities that are determined by 3 markets which come from power section.

MODEL

- We just calculated a probability about option in probability section.
- We calculated income of each market with revenue and then calculated the expenditure of electricity that produced with cost formulas.

PRICES

- We made up the scenarios taking the prices of Day-Ahead System as a base in order to take action.
- We determined the hourly electricity by finding the average of 100 price scenarios those are built for 720 hours.

OPTIONS

- Using Options formulation, we found whether strike price is lower than average spot market price or not.
- For this, we firstly found probability distributions and then we calculated cumulative distributions.

MARJINAL

- We calculated the marginal value that effects the spot market for each scenarios.
- If the price is higher than the expenditure retail is done and we stated 0 with regard to the formula, but if the price is lower than the expenditure we produce electricity and we stated 1 again with regard to the formula.
- After calculating whether we can sell or not for each scenarios, first ly, we multiplied and added with the values those are derivated according to the SMP datas in 720 hours data price section for the 1st scenario.
- We did this procedure to each scenarios and found the average selling price for each scenarios.
- We wrote all values for each scenarios to Marginal off section in Model page.

POWER

- Not exceeding our capacity of 1000 MWh, we gained 100 scenarios with Excel formulas.
- We distributed 1000 MWh for each 3 markets.

RESULTS

- We calculated and wrote to the table10,000 profit for each situations by using codes those are written with Excel-Macros and Pptions, Bilateral Agreement and Spot market's profit formulas, as a result of the results of 100 scenarios of power and prices scenarios

RESULTS

- Finally, we calculated the average value of price scenarios those are written in Total table.
- And lastly, Excel table gave us the 85th scenario as the most efficient scenario.

Gives us 85.
Power Scenario

Figure 18: Step-by-step all transactions for reaching the optimum result

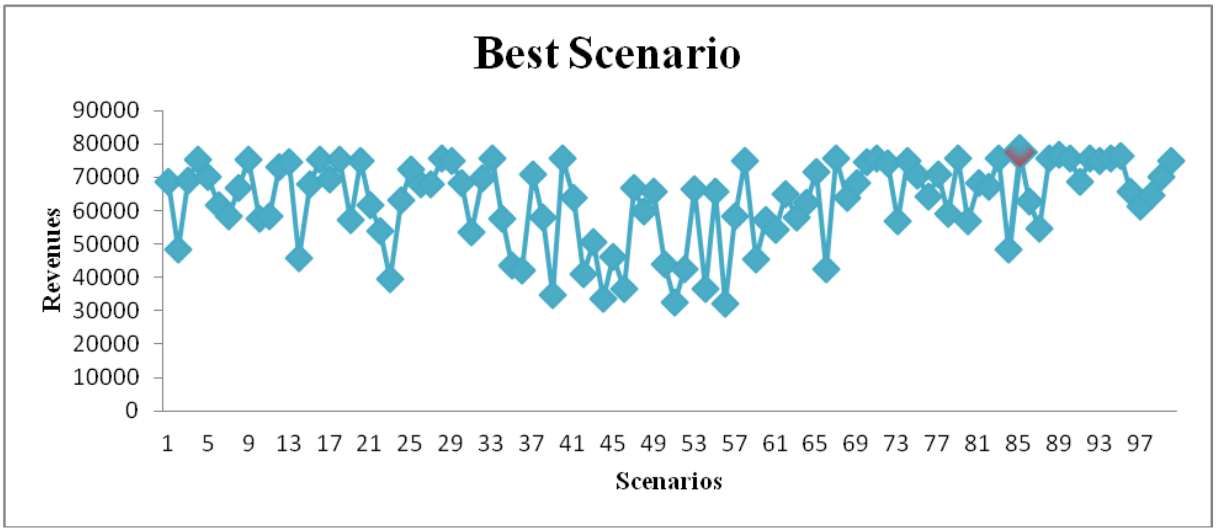
After all steps, we found the best revenue is on the 85th scenario and value is 77156, 21.

Table 8.6.5: Best Revenue

Expected Revenue		77156,21
Option	Q1	735
Bilateral	Q2	135
Spot	Q3	130

The chart below shows the average data and the 85th scenario, which is the maximum efficient one.

Table 8.6.6: Best Scenario



Chapter 9

Conclusion

We built a model that involves derivatives options market, spot market and bilateral agreements and leads us to transact electricity retail without exceeding the capacity of electricity market. Before building the model, we researched Electricity Industry and structure of Electricity Market in Turkey. In manner of this information, our primary goal is to come up with different power and price scenarios and to calculate the profit for each of them. Thanks to our model, we found the best scenario that will have the most efficiency for each scenario.

In accordance with this goal, the model is developed to find the optimum result. After we developed different formulations for our problems in Model Development section, we used market prices which base 720 hours-April 2011 electricity prices and bilateral agreement price that we reached at PMUM, Soma power plant generator data which is sample received for the problem, Excel-Macros Application and our Excel-based prices for the solution. Afterwards, we came up with 100 prices and capacity scenarios. We run these data in Excel in 100 different scenarios using Excel-Macros base and succeeded. Besides, using the data till reach to Total Result table, we calculated marginal price, average spot retail price and forward constraints for each market. As a result of these, we reached to scenario tables for option market, spot market and bilateral agreements. Finally, we got the Total Result table. We calculated the average price for each power scenarios in this table. Consequently, we reached to 85th scenario which is the most optimal.

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