

## KNOWLEDGE TRANSFER AND A DECISION-MAKING SIMULATOR FOR THE EUROPEAN DEREGULATED ELECTRICITY MARKET

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### ABSTRACT

The South East European countries are currently restructuring the energy sector. In addition, there is integration with the EU countries. Reforming the energy sector, especially with respect to market principles and competition in the electricity business, is demanding. In the future situation, roles and responsibility in the electricity sector will be changed and new businesses will be established. To survive as companies in the future, sufficient knowledge and skills to act in the new environment are extremely important. Previously, there was no competition and low focus on economic aspects related to profit and interaction with other countries. Being well prepared and at front edge give great advantages for the participants and a well functioning market will evolve faster. In this situation a new energy trading centre has been developed in cooperation between Croatia and Norway. Norway has long experience with a deregulated electricity market. The concept aims not only to educate, but also to promote new business models and intensify future market activities.

The paper describes teaching material at university level and a training simulator that gives the opportunity for different participants from different countries with varying degree of market interest and knowledge to play and experience market behaviors and consequences. The course material prepared for future teachers consists of five books with theoretical background of energy markets. The simulator called MASI established in a laboratory includes a market model that is very interesting for future market model in Europe. The centre is relevant to participants from Croatian and Regional/European markets, e.g. eligible customers, suppliers, traders, system operators etc. This centre is the first energy training centre of the kind in Europe and is funded by the Norwegian Ministry of Foreign Affairs and HEP in Croatia. The Centre will arrange several workshops in the near future.

### INTRODUCTION

Croatia has been reforming its energy sector on market principles and competition in energy business. The energy sector reform is especially demanding in the area of electrical energy. The Republic of Croatia (which in 2004 obtained the status of a candidate for accession to the

European Union and is now in the screening process), and Croatian electricity company - HEP (which strives to be a full and equal participant in the European electricity market) have been working at an accelerated pace to meet the requirements of the European Commission. Under the Electricity Market Act, eligible customers can freely choose their electricity supplier. Since July 1, 2006, eligible customers have been customers with an annual consumption of over 9 GWh. Further opening of the electricity market is set:

- by July 1, 2007 for customers in the commercial category,
- by July 1, 2008 for all customers

As the consequence, new suppliers and traders will enter the market.

The Energy Community Treaty, signed on 25<sup>th</sup> October, 2005 in Athens and ratified by the Croatian Parliament in May, 2006, is a process that aims to extend the EU internal energy market to the South East Europe region (SEE region). It is a basic document, which integrates Croatia in the energy system of the European Union, even before the official accession. Main goals are to create a stable and regulatory market framework capable of attracting investment, to create a single regulatory space for trade, to enhance security of supply, to improve the environmental situation and to develop electricity and gas market competition on a broader geographical scale. With this Treaty, Croatia will enhance its security of energy supply. National companies will have the possibility to enter into energy markets of EU and South East Europe and at the same time foreign companies will have the opportunity to extend their operations in the SEE region. Competition in generation and supply provides new business opportunities (like expansion of other energy and non-energy business) and strategic business alliances with partners at home and abroad.

Taking into consideration reforms in the energy sector, market opening, European integrations and new business opportunities, it is imperative to provide knowledge and skills to participants with new roles and responsibilities. The need for more flexibility, readiness and qualification of human resources have resulted in postgraduate and specific studies and several seminars for teaching individuals. The idea is not just to educate, but also to promote new business models and intensify future market activity.

## **ESTABLISHMENT OF TRAINING CENTRE AND BEGINNING OF KNOWLEDGE TRANSFER**

Examining the existing possibilities of knowledge transfer, it can be noticed that majority is offered for more skilled persons with higher level of experience or management level or for persons who need structural education (postgraduate study and MBA). But, energy market is a reality. Because of that, we need to educate as many people as possible in different companies with appropriate knowledge in short time. So there was an idea to have a training centre which would enable the people involved in new business environment and energy sector reforms to understand the new circumstances. Therefore, a co-operation between Croatian Utility Company - Hrvatska Elektroprivreda d.d. (HEP), the Faculty of Electrical Engineering and Computing at the University of Zagreb (FER) and the Norwegian company Technor Energy AS (Technor) have initiated a project with the objective to establish a Centre for education and training of personnel for Energy Trading. The project has been named "Training Centre for Energy Trading" (TCET) and is partly financed by the Norwegian Authorities (86%) and partly by HEP (14%). The companies SINTEF Energy Research, Troma Kraft and Powel from Norway were the experienced contributors in the project. The Croatian energy market operator from Croatia was also included in the project.

By bilateral co-operation, a platform has been established for transferring and producing knowledge and skills required for management, planning, and operation related to Energy Trading. Special attention has been given to the development of curricula for training 1) teaching personnel and 2) market participants. Based on continuous analyses and feedback, new elements will be constantly incorporated in the TCET curricula in order to develop skills that companies may seek in order to develop as competitive market participants. The project started on 1<sup>st</sup> November 2004 and was completed with the official opening of the Centre on 30<sup>th</sup> June, 2006.

In brief, the results of the project are five books with theoretical background of energy markets and a laboratory with MaSi market simulator software (max. 16 persons) for familiarizing attendees with the trading process (bidding and acting on the market). TCET is intended for different types of market participants who will act on the Croatian and Regional/European energy markets: eligible customers, suppliers, traders, system operators, etc. A workshop is organized periodically according to specific needs of attendees and their future role, usually in a week course (five day course). After organizing and creating the Centre (in the implementation and operation stage) with special notice on Development curricula, a workshop for future teachers was held in Zagreb. The teachers are in fact contributors in the TCET project and the purpose was to

improve and accomplish prepared course.

Although the project finished with the official opening, efforts on development of TCET have not ended. The Training Centre is self-financed, with continuation of upgrading the teaching plan and new courses are developing, so the participants and companies can upgrade their acting on energy market using the transferred knowledge. This is the first Centre of the kind in Europe, but its main purpose is for the region of South East Europe. So, the courses are held in English and Croatian.

In mid-November the first public course was successfully concluded. The course was organized for employees of Hrvatska elektroprivreda d.d. and its subsidiaries - HEP Transmission System Operator (HEP-OPS), HEP Distribution System Operator (HEP-ODS), HEP Generation, HEP Trade and HEP Supply. In addition to Croatian lecturers, the course was conducted by colleagues from Troma Kraft. As a specialty of the course, an additional presentation entitled Strategic position in the end user market was given by the leading managers of the Swedish supplier Kraft & Kultur. The mentioned supplier is renowned for selling electricity with goods and services linked to culture (like magazines, tickets for various performances, etc.) tourism, ecology and third world care. Next courses will be held by the end of January, March and May, 2007, so every two months or in different time depending on specific participant needs.

## **DOCUMENTATIONS IN SEVERAL BOOKS**

Book 1 is called Training Centre for Energy Trading, Executive Summaries [1] – executive summaries of the next five books.

Book 2: An Analysis of the Croatian/South East European Situation Regarding the Free Energy Market Implementation – is giving the basis for creation of energy markets: Energy Charter, energy strategies, energy directives, energy laws. Organisation of energy markets and energy utilities is described. Power balance in the region has been elaborated as well as the situation in the SEE region (Italy, Austria, Hungary, Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Monte Negro, Romania, Bulgaria, and Macedonia) and Norway/Scandinavia, as an example of the most liberalized region in Europe. Customer choice of supplier and supplier choice of generator is explained as well as examination of possibilities in competition and trade in the region and Europe.

Book 3: Elements for Electricity Trading [3] – The report contents serve as a starting point for learning the fundamentals of electricity trading. This covers the roles and responsibilities in market interactions, rules of participating in electricity markets etc. Examples and experiences from Nordic power market are supplied. Moreover, the report includes Croatian and regional

specifics as well as several topics such as System Operator responsibility, network access and tariff systems, network capacity and flow, information in the market, participants and their interests, spot price formation - function and process, TSO's operational tasks regarding spot price formation, balancing markets, congestion management, transit, cross-border arrangements and efficiency, trading in physical markets, trading in financial markets at exchanges.

Book 4: Operations and Strategies [4] – this report is made to give a general knowledge about market processes adaptable to the future structure of electricity market in Croatia or anywhere else. The contents in this report include trading issues, contractual problems, analyses, forecasting, spot market bid, customer obligations, information obligations and economic obligations, and a brief look at the probable future structure of the industry. It also includes terminology (types of electricity transactions), contractual participating conditions, strategic long-term, mid-term and short-term motivation and planning, price forecasting (fundamentals of energy trading), use of different Trading Products, bidding strategies, bilateral and on Power Exchanges and business structures for market based operations.

Book 5: Risk Management and Hedging [5] – The book contains a discussion on financial instruments and options - futures and forward contract, an option, forward rate agreements, interest- rate swaps also known as derivatives. The risks (market and credit) involved in using these instruments are also explained. Other topics are also included, as identifying different type of risks, responsibilities in risk management, risk limits and reporting with examples, financial instruments and options, hedging strategies and tactic development, implementation and monitoring, hedge performance analysis (hedge portfolio), real time trading and hedging examples for all products. The main strategies in using different instruments to manage (lower) risk – hedging are also discussed in the book.

Book 6: Models for Power System Planning [6]

The objective of this book is to describe and evaluate current Croatian and Norwegian situation regarding the models of power system planning. It includes chapters on grid development plan in short-term, medium and long-term, local, regional and European context of planning, production investments, reserve planning, power system security, and authority monopoly regulations. In this document, the Nordic approach has been compared with those currently used or planned to be used in Croatia, and as such, adapted to the conditions and frameworks we find here.

## THE POWER MARKET SIMULATOR

The actual course consists of two components – lectures and

practical work (laboratory) on power market simulator. The laboratory is made in the Faculty of Electrical Engineering and Computing, where the participants play different roles of market participants (suppliers, producers, traders) and the teacher plays the role of market operator and system operator. Simulation is supported by a program package, with the purpose of giving different scenarios to the participants for acting on electricity market. For the purpose of TCET, the unique tool has been developed – *MaSi* (Market Simulator). *MaSi* has been developed by the companies Powel and SINTEF Energy Research on the basis of previous tools which are used by the participants on Nordpool. The simulator consists of bidding tool, power exchange pricing tool, analysis of power flows and area pricing model.

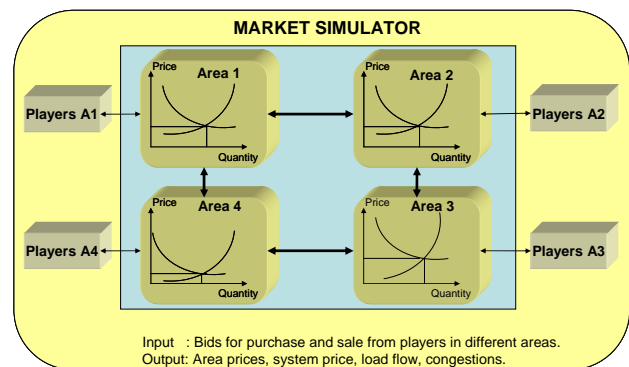


Figure 1. Market simulator

*MaSi* [7] is market simulator for teaching basic trading on power exchange. It is used for the purpose of trading, trying out different market participants bidding strategies. Spot price is calculated hour by hour, based on bids from participants, and bids are analyzed after the price is calculated. It is based on two main components – tools *Bid* and *SpotEx* [8]. Commercial tool *Bid* has been developed by Powel for spot market trade on Nordpool. *Bid* executes the bids and accounting between the player and the market operator. The application *SpotEx* has been developed by SINTEF Energy Research and its major functionality is calculation of the system and area prices. In addition, it calculates the load flow between the areas. All input is based on bids from the Powel *Bid* application that is integrated in *MaSi*.

*MaSi* manages the spot market including bilateral contracts, based on the rules from Nordpool and on the European rules because of trading in meshed European grid. With further development of this software, it will be possible to simulate market conditions in Continental Europe.

For the purpose of education and simple analysis, there has been established, within *MaSi*, an artificial power system divided in four areas North, East, South and West.. The countries are connected as a loop (West-South-East-North-West), as shown in Figure 2, which gives any transfer

between any two countries only two possible paths. Since the power flow used in this model is linear, the ratio between the power transfers on the two paths will be given by the ratio of the sum of the impedances for the paths respectively. Market operator in *MaSi* runs the Spot exchange and is an information hub for the needed information. He is also a Cross Border capacity allocator who accepts/rejects Cross Border trades and informs about available Cross Border capacity, and he also has the role of a system operator for informing about any congestions in the grid. He also sends urgent market messages to the participants (like power plants are out, due to a failure).

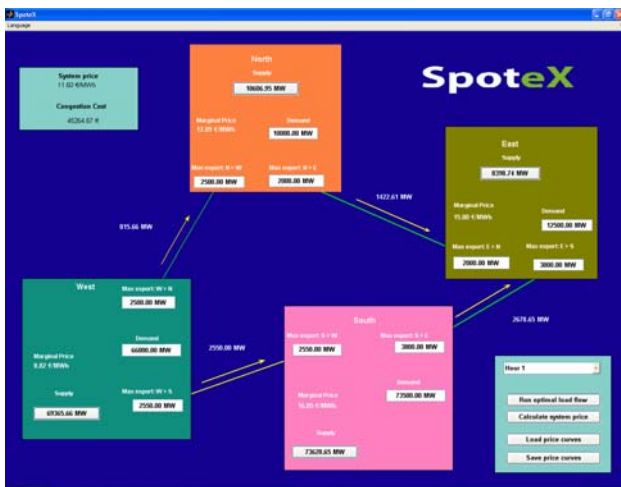


Figure 2. Result of running an optimal power flow

*MaSi* can use the maximum of 16 participants divided in 8 groups of electricity traders. Market operator (lecturer) collects bids from traders (participants), controls the market, and calculates the system price and area prices. In other words, the operator manages the simulation. Bids cannot be mixed – a bid can be a sell bid or a buy bid. Buy bids must be price independent, and sell bids must strictly be declining. Minimal time resolution is an hour.

After the acceptance of the bid, the trader can analyze his bids, by hour and by area, as well as the total bought and sold electricity quantity, revenue, (marginal) costs, and profit. Depending of the bid type, results are separately shown for producers, and separately for suppliers (who sell energy to final consumers by contract prices). The whole analysis is made in a separate report. If we want to calculate production costs, producers must take care of marginal costs of power plants and the type of power plants they have. The strategies used by the participants can be compared. Because the consumption in the simulation is inelastic, the best trader is the one who has sold more electricity in the hours where it has been expensive and less in the hours where it has been cheaper. In the end of the course we select the best trader who receives an appropriate reward for trading. In the end of each day in a five-day course, the participants have an exam from lectures and in the end of

the course successful participants receive certificate with 3 ECTS.

## CONCLUSION

Taking into consideration reforms in the energy sector and new business opportunities, it is imperative to provide knowledge and skills to participants embracing new roles and responsibilities. The idea of the TCET is not just to educate, but also to promote new business models and intensify future market activity. TCET is intended for different types of market participants who will act on the Regional/European energy markets: eligible customers, suppliers, traders, system operators, etc.

More information on the knowledge transfer and decision making simulator for the European deregulated electricity market can be found in [9].

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