The New Information System for Imbalance Settlement of Slovenian Market Operator

I. Lorencin, A. Šavli, D. Stanek, B. Strmčnik

***Abstract* — In this paper an integrated balancing and information system (iBIS), which the Slovenian market operator (Borzen, d.o.o.) will use to administer imbalance settlement is presented. Operation of electricity market requires management of considerable amount of data interchanges among different market participants. To make market operator's risk management more effective and to make the job of administrators handling imbalance settlement easier, automated, and user-friendly, the open application iBIS provides accurate and timely support.**

***Index Terms*—ETSO Settlement Process, e-business in energy, imbalance settlement, information technology.**

I. Nomenclature

MO – Market Operator
BRP – Balance Responsible Party
BG – Balance Group
BSG – Balance Sub-group
ELES – Elektro Slovenija
TSO – Transmission System Operator

II. Introduction

ENERGY supply comprises a systematic field of activities composed of production, trading, transmission, distribution and use of energy. With opening of electric market circumstances in energy sector were changed. Market environment put pressure on participants to cut down costs and increase productivity and added value.

On the other hand, market operation, because of complexity, depends on data exchange. Thanks to development of information technology and internet new services, which are closely linked with data exchange, are taking shape in energy sector. One of the key services is imbalance settlement which is dependent upon a finalised schedule, regulation and metering data.

III. Electric energy system balance

Electric energy system operation is stabile if the production and use of energy is in balance in every moment of operation [1]. Because electric energy is non-storable the nature of alternating current dictates constant looking for system balance.

Deviation from balance must be annulled quickly. For short term intervals automatic generation control plays a crucial role in matching load to generation [2].

In past the vertically integrated electricity companies which integrate production, transmission, distribution and retail assure balance in electric energy system. With energy market opening and deregulation electric energy system is not any more under operation of one vertically integrated company that operate whole supply chain of electric energy. As a rule the electric energy system is divided in production, transmission, distribution and retail. Production, trading and retail are market activities that seek balance on energy market. Between production and retail there is transport of electric energy over transmission and distribution network.

In such circumstances the assurance of stability of electric system operation is task of system operator. In Slovenia this task is trusted to transmission system operator ELES.

Whole process of imbalance settlement flow according to following time schedule:

- Day D-1:
  - Energy trading.
  - Submitting of BRP schedules.
  - Operation planning.
- Day D:
  - System operation.
  - Metering of actual production and consumption of energy.
  - System balancing.
- Day D+:
  - Collecting, aggregation and submitting of metered data.
  - Imbalance settlement.

These tasks are divided among ELES TSO, SODO DSO, and Borzen Power Market Operator (hereinafter MO). ELES TSO is responsible for balancing of system for the metering ELES TSO and SODO DSO are responsible, however for the imbalance settlement both ELES TSO and Borzen Market Power Operator are responsible. In the intermediate period before new rules for the operation of the electricity market are accepted, the financial settlement of the imbalances is divided between the two. Some of the BRP, which have balancing agreements concluded only with ELES TSO, are settled by the TSO, the newer ones, which have signed trilateral balancing agreements with TSO and MO, are financially settled by MO.

By signing a balancing agreement, any participant on the market can establish a BG, or, by signing a compensation agreement with the responsible person of the BG, any participant can become a member of a BG as a balance sub-group (hereinafter BSG).

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Since BGs are directly responsible to MO, financial part of imbalance settlement is only made for the BGs and not for the BSGs, which settle their imbalance with the superior RBG. The participants can freely decide which BG or BSG they will affiliate with on the market, depending on which they find most advantageous. Market participants join BGs and BSGs mainly to lower the costs resulting from imbalance settlement. BGs with more clients, and if possible with their own production capacities, are in a better position to cover imbalances. A greater number of clients provide a more diverse selection of daily consumption diagrams and with this a lower overlap factor, while one's own production, in addition to easier and more flexible consumption coverage, also affects the width of the tolerance band, which is of considerable importance in the current system of penalising deviations outside the tolerance bands.

Above mentioned functions of imbalance settlement process are highly dependent on various data exchange among different companies and market players. Because of that MO needs an environment which enables standardised data exchange to support those processes.

IV. E-BUSINESS IN ENERGY

Business management includes production, selling and buying of products and goods, and also selling of services. For execution of above mentioned activities we need different information.

The change of the way in which information is exchanged for coordination of tasks on the electricity market, as well as inside any company, is one of the main characteristics of electronic business or e-business. Data exchange is executed on a computer network by using information technology. Thus we could define e–business as business that uses information technology for data exchange in coordination of activities between specialised participant on the market as well as inside any company.

Free energy market from their beginning in the mid 90's required development and use of various data exchange techniques. The most used standards were:

- UN/EDIFACT (Unated Nation / Electronic Data Interchange For Administration, Commerce and Transport), and
- ebXML (Electronic Business using eXtensible Markup Language).

EDIFACT is traditional standard, which was formed under the cover of United Nations and is widely used in various industries for data exchange. On the basis of EDIFACT some companies formed standard EDIEL (Electronic Data Interchange for the Electricity Market Trading) which is in use on energy market in Scandinavia and later on standard EDINE in Netherlands.

ebXML or Electronic Business XML is standard for e-business and is non-official successor of EDIFATC standard. ebXML initiative defined in years 1999 to 2001 developed many specifications which determine this standard. Vision of initiative is development of international specifications for unified international market that will base on data exchange by XML.

Goal of initiative is to establish e-business infrastructure on the XML basis that will be interoperable, consistent and secure [3].

Such infrastructure could be applicable as for multinational corporations and also for small and medium enterprises in all branches of economy [4]. As well as EDIFACT, ebXML was established in some part of electric energy market as e-business standard. Organization The European Transmission System Operators (ETSO), which associated transmission system operators from Europe take over a leadership in standardization of electric energy market data exchange on the basis of ebXML architecture. ETSO established working group ETSO EDI Task Force 14 for standardization of business processes and data exchange. Working group is responsible for energy market modelling, business process modelling and definition of XML scheme for energy market data exchange.

Since its creation, ETSO TF 14 has developed the following industrial standards in compliance with UN/CEFACT and ebXML recommendations:

- EMM: ETSO Modelling Methodology.
- ERM: ETSO Role Model of the Electricity Market.
- EIC: ETSO Identification Coding Scheme to identify parties and domains in the IEM.
- ESS: ETSO Scheduling System for scheduling exchanges.
- ESP: ETSO Settlement Process for settlement information exchanges between parties.

ETSO standards are published as Implementation Guides to enable IT vendors to develop software solutions. ETSO standards were implemented in the wholesale markets of Austria, Croatia, France, Germany, Hungary, Poland, Serbia, Slovenia, Spain, Switzerland, etc.

Business process definitions are key characteristic of ebXML standard [4]. Business process is defined as composition of logically interconnected activities which results in planed products or services. Business processes emphasis didn't start with ebXML, the later is first initiative that tries to implement business modelling in interbranch electronic business.

Basic concept that ETSO take from ebXML initiative is standardised way of business processes description and modelling. For modelling of business processes ETSO as well as ebXML use Unified Modelling Methodology UMM, which was developed by UN/CEFACT [6]. Beside business processes ETSO also developed core components that is used in data exchange protocols and data modelling.

Process of implementation of e-business in electric energy market goes by following procedure:

- Modelling of business process.
- Definition of needed information.
- Definition of XML schemes.
- Development and implementation of applications.

V. IMBALANCE SETTLEMENT

Imbalance settlement is process of calculation of deviations between metering data and schedules announced by Balance Group Responsible. First outcome of this process are quantity imbalance calculations that represent

hourly energy quantity deviation (in MWh or kWh) for the whole settlement period (currently 1 month). Second outcome is financial imbalance calculation that represents financial valuation of deviation.

Imbalance settlement is the last phase of the multistep process which includes scheduling, energy system operation planning, operation, balancing, metering and settlement.

The full balancing process is according to ETSO methodology broken into three phases:

- A planning phase. Planning phase is on Slovenian market finished on day D-1. As a result, finalised schedules prepared by Borzen are sent to ELES.
- An operation phase. Finalised schedule is in operation. ELES is responsible to balance deviations of balance groups. Inside this phase there is also metering process.
- A settlement phase. Borzen administers the imbalance settlement.

Participants in imbalance settlement process are:

- Borzen as a market operator is responsible for recording of bilateral contracts concluded by market participants and nomination of operating schedules of all production and consumption units in Republic of Slovenia.
- Based on recorded bilateral contracts and nominated schedules Borzen prepares an operating schedule of Slovenian electricity system which is sent to ELES TSO.
- ELES as transmission system operator inserts changes to the schedule if there are any technical restrictions. ELES is also responsible for preparation of regulation data, metering data and data about balance energy costs.
- SODO DSO as meter data aggregator is responsible preparation of aggregated metering data (SODO DSO has five distribution areas).
- Borzen as imbalance settlement administrator and billing agent administrates imbalance settlement process.
- Balance groups as balance responsible parties are responsible for scheduling and financial settlement of their imbalances.

Data used for imbalance settlement:

- Final operating schedule;
- Aggregated metered data for every BG and BSG;
- Regulation data (quantities and costs);
- Settlement pricing information (e.g. balance energy costs).

Imbalance settlement process is composed of following use cases (Fig. 1):

- Approvement of the schedule.
- Calculation of finalised schedule.
- Collection of regulation data.
- Collection and aggregation of metered data.
- Deviations calculations.
- Acquisition of balance energy costs.
- Invoicing of imbalance settlement.

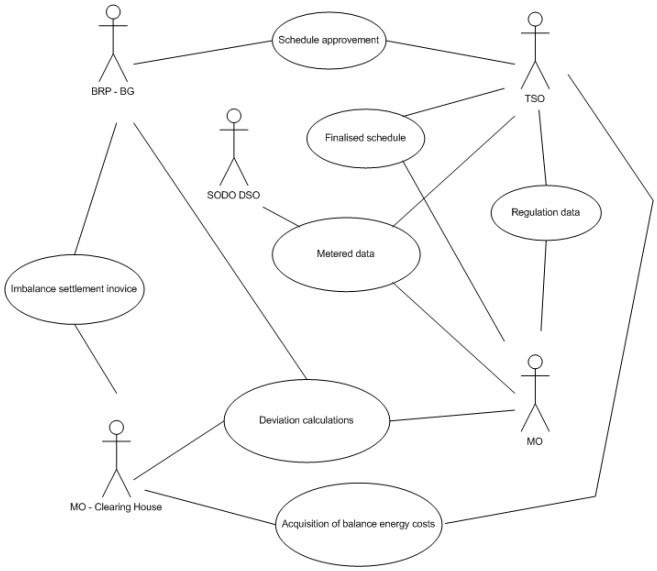

Fig. 1. Imbalance settlement process use cases.

Sequential diagram of imbalance settlement process is present on Fig. 2. Diagram is build up according to ETSO Settlement Process Implementation Guide [7].

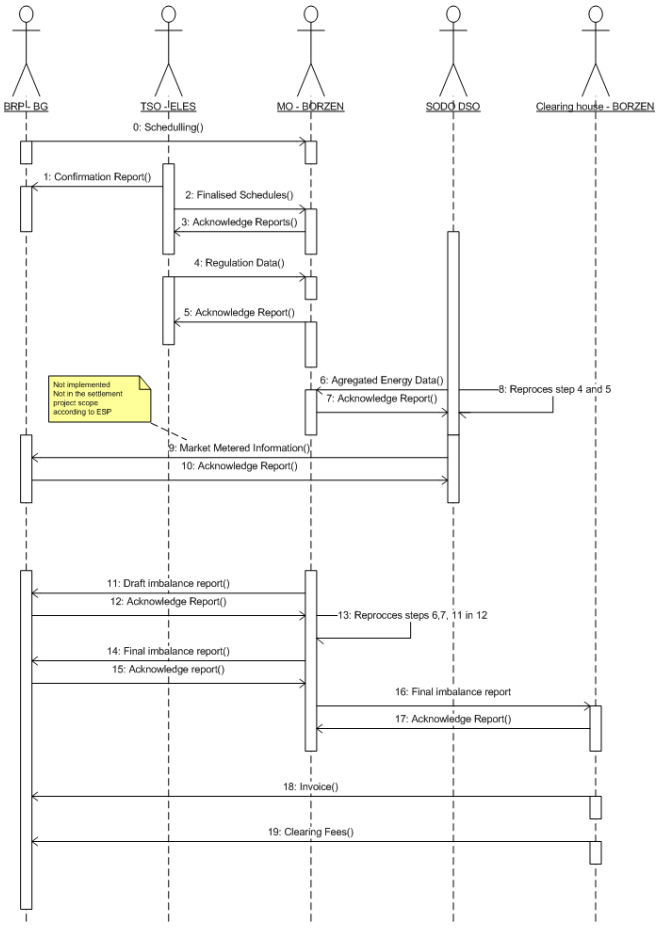

Fig. 2. Sequential diagram of imbalance settlement processes.

Sequential diagram show sequences of data exchange

and interactions between imbalance settlement process participants. Individual message trigger particular activity of objects. Sequential diagram shows interactions between objects like sequence of events. Emphasis is on chronological course of events.

Data exchange for imbalance settlement process goes by Excel files. In near future those files will be probably exchanged with communication protocol based on XML.

The following activities are being undertaken as part of the financial settlement:

- Calculation of the hourly index C_{SLOeX},
- Calculation of the basic prices for imbalances C_+ and C_-,
- Calculation of the tolerance bands,
- Calculation of the imbalance prices C_p and C_n and
- Calculating the amounts for the financial settlement.

Calculation of basic imbalance prices is one of the more important components of imbalance settlement since it provides a clear price indication for the market participants and motivates them towards better coverage of their daily consumption and production diagram. Two basic principles for determining imbalance prices are used in Europe. These are the dual imbalance pricing, by which the prices for positive and negative imbalance are set separately, and the single imbalance pricing, by which one price is set for both negative and positive imbalance volumes.

In Slovenia the dual pricing principle for imbalance settlement is being used. The basic imbalance prices C_+ and C_- are calculated from TSO costs for imbalance settlement and the hourly price index for electric energy C_{SLOeX}, which is calculated from the data on trade on the organised market. The price C_+ is the price at which the RBG is due to pay for positive imbalance within the tolerance bands, and the price C_- is the price by which they are reimbursed for the negative imbalance within the tolerance bands (T).

Slovenian market rules provide that deviations from the operating schedules are penalised. For this purpose a tolerance band for a BG is set for each interval in order to determine whether it has exceeded the permitted tolerance band with its imbalance.

$$T = \pm k \cdot \sqrt{\frac{W_{cons.} + W_{prod.}}{\max(W_{cons.}; W_{prod.})}} \cdot \max(W_{cons.}; W_{prod.}) \qquad (1)$$

The calculation of the tolerance bands is shown in equation (1). The tolerance band is roughly the size of 5 percent of the value acquired from the data on the realised production and consumption (coefficient $k = 0.05$).

The tolerance band is used in calculation of the imbalance prices of individual BGs. The prices of positive imbalance C_p and negative imbalance C_n are calculated separately for each accounting period. These two prices depend on whether or not the BG imbalance exceeded the tolerance band.

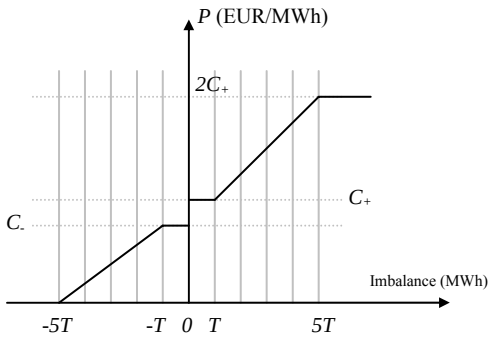

Fig. 3. The diagram for determining the prices for imbalance settlement

Fig. 4 shows the diagram for determining the prices for imbalance calculation, which illustrates how penalisation affects the imbalance prices. If it exceeds up to five times the tolerance band in the positive direction the C_p its value is double the price C_+, and if it exceeds up to five times in the negative direction the C_n for returned energy is lowered to zero.

VI. Integrated Balance Information System – iBIS

Borzen, Power Market Operator is developing a new web-based application for the administration of imbalance Settlement. The application called Integrated Balance Information System – iBIS – is being developed by Slovenian company Korona, Power engineering.

iBIS is build up as intranet based application in .NET Microsoft technology. Database is developed in Microsoft SQL Server 2005. Application is modular and open for additional modules and functionalities, which can be added to the system. User friendliness and modern design make application easy-to-use.

The basis for imbalance settlement management is balance scheme as shown in Fig. 4. Tree structure on the left side of user interface makes navigation easier.

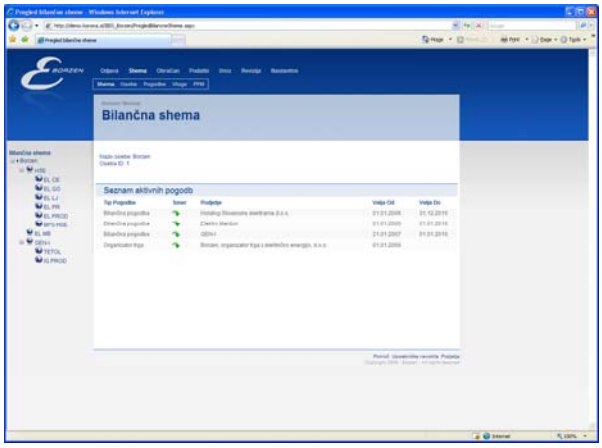

Fig. 4. Balance scheme user interface.

The basis for definition of balancing scheme, which is composed from BGs and BSGs, are two tipes of contracts among market participants, which are also used in the imbalance settlement process. These two contracts are balancing agreement between MO and a market participant, and compensation agreement between two market participants. Module for contract management enables easy-

to-use management, changing and entering of contracts (Fig. 5).

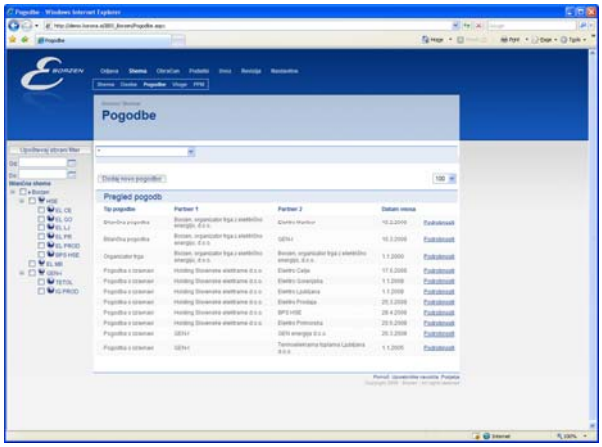

Fig. 5. Contract management user interface.

Calculated imbalance settlement reports are reachable through imbalance reports module (Fig. 6, 7 and 8). Imbalance reports could be exported as HTML, PDF, XML and Excel files.

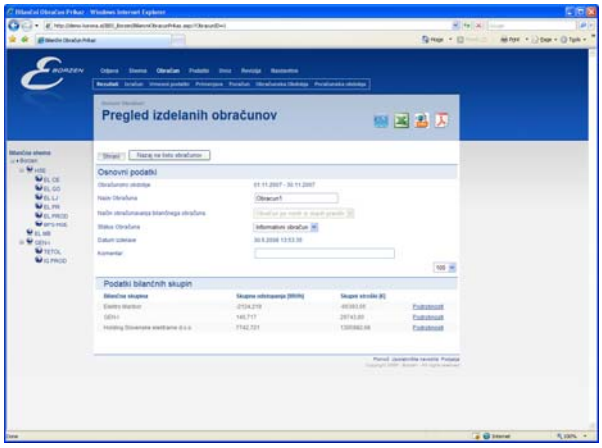

Fig. 6. Finished imbalance reports list.

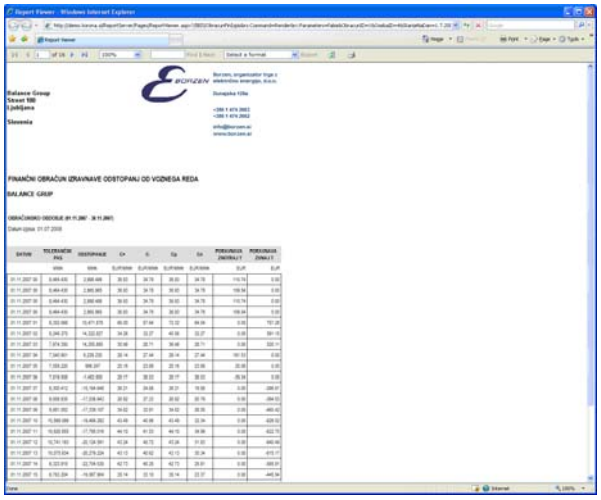

Fig. 7. Imbalance report exported in MS Report Viewer.

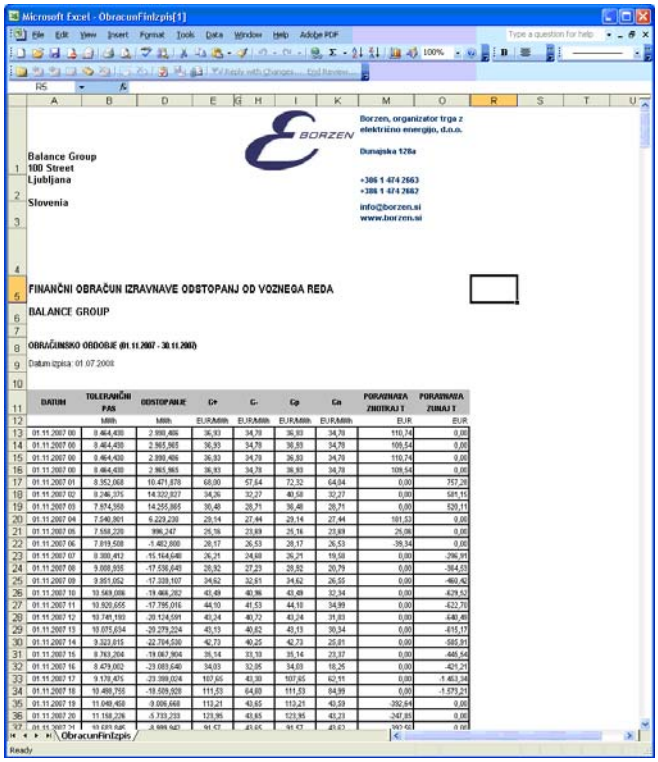

Fig. 8. Imbalance report exported in MS Excel.

One of the important added-values of new functions of application is so-called “revision” (Fig. 9). This function enables the administrator of the iBIS to return the state of database to a specific date in the past and simulate that state. In this way an effective risk management can be performed in which calculation of imbalance settlement can be repeated based on all previous versions of the database.

This is important since the metering data are constantly corrected by the system operators during the process of imbalance settlement. Therefore market operator has to be able to repeat all the previous calculations, which have been made.

Data in the data base is never over-written or deleted - once committed, the data is static, read-only, and retained for future reporting, comparison and data checking. User could start a revision mode through user interface by selecting a date. After that start of revision, the whole application functions in the state of revision and uses the data as they existed on that specific date.

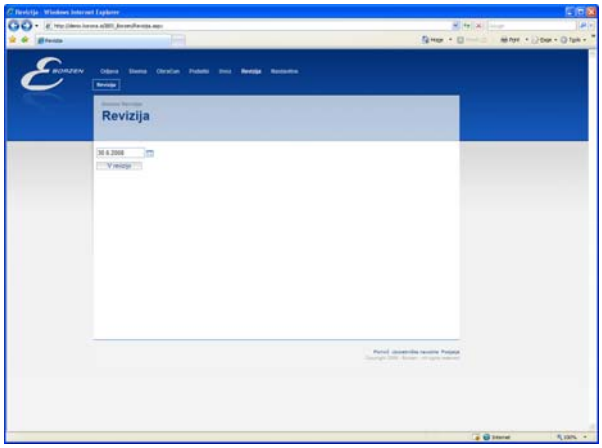

Fig. 9. Revision management module.

VII. Conclusions

Experiences show that operation and performance of energy market processes depend on accuracy and timing of data exchange. Data exchange and information technology play an important role in supervision and control of electric energy system. It started long time ago with Supervisory Control and Data Acquisition Systems (SCADA), metering and protection. By opening of electricity market, the part of activities linked with system operation planning and management were distributed from vertically centralised decision making to market – requiring the data coordination mechanism and exchange between diversified parties for decision making.

Although the number of wholesale market participants is relatively small, it is necessary to exchange large amount of accurate and timely data for the electric energy system operation. For exchange of information and imbalance settlement management, Integrated Balance Information System (iBIS) system was developed.

New information system enables Borzen to step on new level of performance and supervision of electric energy market. Easy to use and user friendly application is important assistance to Borzen's effort to organise stabile and transparent electric energy market. Application enables fast response to various events on energy market, especially in imbalance settlement process. Market transactions are well managed and easy supervised.

System is outcome of common work of companies Borzen and Korona. High quality, user friendliness, modularity and openness of iBIS enable Borzen to be important and trustworthy party in operation of energy market.

VIII. References

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IX. Biographies

Ivan Lorencin was born in Pula, Croatia, on February 15, 1971. He received the Diploma Engineer at the University of Ljubljana in 1997. He currently works on M.Sc. in information technology at the University of Ljubljana. As a project manager in Korona Power Engineering Co, he is interested in development and implementation of information technology and decision support systems for power system operation, planning and economics.

Andraž Šavli, born in 1977, holds a B.Sc. degree in Electrical Engineering from the University of Ljubljana, Slovenia, and works as Head of Market Operations at Borzen, Slovenian Electricity Market Operator. In the past four years he has gained experience in the field of market operations and balancing market, and has taken an active part in the installation and functioning of imbalance settlement and in the development of congestion management solutions.

Damjan Stanek, holds a M.Sc. degree in Electrical Engineering from the University of Ljubljana, Slovenia. He has been the General Manager of Borzen, the Slovenian Power Market Operator since 2003. As Borzen's General Manager, he introduced a new strategy to establish an active and competitive Slovene market and to support its integration in the European internal market. At the end of 2004 he was appointed President of EuroPEX (Association of European Power Exchanges) for a two-year term. In 2005 he was appointed to the working group in the national reform committee and later that year also to the working group for the privatisation in the electricity sector.

Boštjan Strmčnik was born in Ljubljana, Slovenia, on July 4, 1965. He received the Diploma Engineer, M.Sc. and Ph.D. at the University of Ljubljana in 1990, 1993 and 1996, respectively. Currently he is working as a managing director in Korona Power Engineering Co. As an associate member of the Power System Laboratory at the University of Ljubljana he is interested in power system operation and planning.

Special Note: This BPC Paper Template relies heavily on the well known IEEE PES Technical Paper Template. We would like to point out that due to the specifics of the Balkan Power Conference there are some important differences not in the general outlook of the template but rather in procedures described in the template.