

**OPERATOR PERFORMANCE REQUIREMENTS AND TRAINING NEEDS
IN THE COMMERCIAL ENVIRONMENT**

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1. ABSTRACT

The implementation of system and/or market operation entities in electrical utilities throughout the world and the unbundling of the electricity industry has changed the environment of the energy supply business from a mainly technical to a more commercially dominated one. The increasing number of different companies with diverse interest participating in the electricity supply business leads to a shift from traditional tasks of power system operation among these companies to new additional job duties or even a complete new job as system or market operator. The requirement to run the power system under commercial constraints to its limits and still maintain full system security impacts strongly on the performance standards that must now be met in – especially – system operators’ positions and on the training needed to fulfil their role. This paper examines the changes that have taken place in the commercial environment in which power system operators now work and how that affects their day-to-day operations. Then performance targets that have already been implemented world-wide are identified and the impacts on the job to be performed by the system operator are described. Finally the training needs of system and market operators personnel in systems where these entities are separated are pointed out, focusing on the new points that have arisen because of the new commercial environment.

2. INTRODUCTION

The Electricity Industry world-wide is facing a new operational environment changing from the classical technically driven operation towards a commercially customer oriented business. This process is usually initiated with a definite time schedule by diverse institutions such as the European Union, the Ministry of economic affairs or the government like in the US. The direction is towards a competitive electricity supply business. The structure of the industry is changing and, in some cases, takes a specific amount of time in a situation which is faced nowadays: **SO/TSO** and **MO** are separated and settled in different kinds of regulation which influence the system operator and the market operator in different ways. **Physical transmission** and **Economic trading** are separated. **Agents** are separated from the **SO/TSO** and **MO**. **Settlement of imbalances** is a specific task. **Physical transmission** and **Economic trading** are separated. **Agents** are separated from the **SO/TSO** and **MO**. **Settlement of imbalances** is a specific task.

Fig. 1 Commercial electricity supply business
 Another certain number did not yet start with that process but will do so in the near future.

Diverse schemes and models for electricity supply business in a commercial environment have emerged so far world-wide resulting in different structures in different countries [1]. Despite of this situation it can be stated that the new environment replaces the classical monopolistic energy supply.

From a global point of view the electricity supply business is separated into the technical energy transmission environment (based on real-time power dispatch, i.e. MW) and the economic energy trading environment (based on financial energy trading, i.e. MWh) as shown in Fig. 1. They are linked to each other by the settlement of imbalances. Different unbundled entities (agents) are linked physically to this transmission environment and economically to the trading environment.

The technical transmission environment is under responsibility of the **system operator** (SO) who has the responsibility to fulfil the two basic tasks:

- Providing security of the interconnected power system
- Balancing power/frequency of the system.

The system operator acts depending on the **transmission asset ownership** as

- **Transmission System Operator** (TSO), if overall system operation responsibility and asset ownership belong to one and the same company (common in Europe). In this case the transmission system is operated by the system operator.
- **Independent System Operator** (ISO), if overall system operation responsibility belong to an independent company (like in the US, South America, Australia). The transmission system is operated by one or more transmission agents under supervision of the system operator.

The **market operator** (MO) is responsible for the overall economic trading environment. This entity can either be

- **integrated** into a system operator like in Argentina, PJM (Pennsylvania–New Jersey–Maryland) or NYPP (New York Power Pool) or be
- separated as an **Independent Market Operator** (IMO) like in Scandinavia.

The **framework** of the new environment (Fig. 1) defining duties and responsibilities of system operator, market operator and all the agents are settled in different kinds of regulation which influence the system operator and the market operator in different ways.

Grid code, co-operation rules and market rules also define the mutual **interfaces** between system operator and market operator as well as the interfaces between each of them and the diverse agents like suppliers, distributors and consumers that are physically connected to the transmission grid and/or trading in the market environment. Referring to this framework, system operator and market operator have to act in a non-discriminating way and transparently with regard to tariff structures and decision making. Furthermore, the **metering and settlement code** defines the

interface between system operation and energy trading and contains the basis for the settlement of imbalances.

The unbundling of the traditional monopolistic physical transmission environment leads to an increasing number of parties with different goals and interests in energy supply business, but general tendency is the merger of companies with similar responsibilities after a while. The economic energy trading environment is usually set up after the unbundling process – albeit unbundling is not a necessary condition – by establishment of a market entity under responsibility of the market operator (MO). Besides that, additional new agents without any physical link like traders and brokers join the electricity supply business. During the transition process from the traditional to a commercialised environment stepwise changes of the participating entities in doing their business is observed.

All this leads to a changed organisation within each participating company and influences the technical overall power system operation as well as the economic trading operation. Therefore, **new requirements in operation** are seen for each of the entities which also cause the necessity to **review the existing training programs**; design and implementation should be modified in order to cope with these changes [2,3].

Furthermore, introduction of training program accreditation as well as the certification of the individual operators are also results of this new environment. It is observed that during environment set up and establishment, a regulatory entity (if it exists) forces formal approaches of certification. This topic is discussed separately in [4] and therefore not focused further in this paper.

3. IMPACTS ON POWER SYSTEM OPERATION

The competition in an open electricity market leads to a greater cost awareness in all participating companies. Investments are reduced to a minimum, and the system is going to be operated closer to its limits. Furthermore, to reduce personnel costs a higher grade of system automation even down to the distribution level is introduced, and at the same time the control areas are growing due to the merger of control centres. All this leads to a **higher workload of the operators** in the control centres.

The establishment of the market place results in additional parties which are using the transmission system. An **increasing information exchange** between the system operator and the market operator is being observed (such as for operative programs, trading, transaction and congestion management) [5], and also among neighbouring operators (cross border trading and operation). The settlement of imbalances has been established as the link between the physical and the trading environment which effects the interaction of

system operator as data and information providing instance, the transmission agents as main measuring instances and the market operator as billing and accounting instance.

Thus, even if the physical system operation in general has not changed, a shift of tasks and duties lead to new requirements to system operators; and even if energy trading is not new in the electricity industry, it is now done via the market involving the entity of a market operator which is also a new business area in electricity industry.

The physical operation tasks and duties as well as responsibilities are formally well distinguished as system services/responsibilities and transmission services/responsibilities. Whilst in former times there was a higher focus on the physical aspects of system security voltage profiles, power/frequency balancing and re-dispatch, there is now more concern about the commercial aspects of these issues and on dealing with the added complexities derived from the presence of many actors. The appearance of regulators and of external parties increase the need for having **quality indices** to assess in a more formal way the performance of the system operator. The above mentioned issues also objects of **commercial interest** now requiring a different handling.

The prevailing conditions to fulfil these tasks have changed and also new tasks have arisen. Due to economic trading activities (e.g. hour-ahead market, balancing market) tasks which were formerly done by offline operation planning become now **time-constrained activities** and are moved into the online operation control centre (e.g. transaction management). Generator contracting, spot market activity, transmission transit (transaction) handling, congestion management are new tasks. Depending on the framework additional tasks like buying losses from generators (e.g. in Finland) or reserve management taking interruptible customers into account (e.g. as introduced in Argentina) result in **changed operation principles**.

Besides, the marketplace usually starts with dealing energy in terms of MWh. New market services and products are developed and commercialised rapidly to increase competitive trading in the electricity supply business [e.g. 6,7,8]. The system operator has to take into account that during the establishment of the market entity not all products which are necessary to fulfil the system operation responsibility are available in the market.

Due to the fast and frequently changing trading environment (e.g. PJM market rules have changed many times in the last two years) ongoing influence on power system operation is observed. As the new market place develops, however, system operator tasks like transaction management increase as

- more and more participants join the trading environment,

- the market demands faster and better methods to do the business.

Even in already established transmission and trading environment changes take place. The UK market (which was established as one of the first) for example will be changed completely by separating the market operator and the system operator. The new market will consist of three main building blocks:

- Incorporation of the demand side,
- Firmness of bids (so that market participants are exposed to the costs and consequences of their actions),
- Simplicity of bids (to improve transparency and move the management of cost structures onto the individual bidders).

In addition, there will be two further aspects which have been agreed to be important components of the new arrangements:

- Move trading closer to real time system operation to allow more accurate prices and to allow any interactions with the gas market,
- Bilateral trading between market participants.

The establishment of the market operator as a separated entity requires also to define the information exchange between system operator and market operator.

4. OPERATORS PERFORMANCE REQUIREMENTS AND TRAINING NEEDS

Depending on the above described impacts operator performance requirements to be met and training needs also change. It is worth to mention that a mutual understanding of jobs and duties between system operators and market operators is necessary. The overall responsibility of each of both entities as well as their common responsibility for the energy supply requires a well designed information exchange with a common understanding.

4.1 Requirements on system operator

Major changes of performance requirements for the established system operator are seen in

- Operation of the physical system,
- Information exchange with market operator and agents,
- Human performance.

The **operation** of a physically interconnected system and the therewith related tasks concerning power/frequency balancing, security and reliability requires an overall system overview as well as overall system insight. Therefore the system operator in its own interest must make sure that the received information like measurement values and equipment performance indicators (e.g. constraints of generators) are as accurate as possible. This is not only relevant for real-time information, but also for forecast values to

ensure that the system operator can perform the job according to its responsibility and the framework.

The tasks and actions to be necessarily performed for reliable system operation have to be delegated to the related agents from the system operator control centre. The responsibility for the correct operation remains at the system operator, who has to make sure that the commands are clearly defined and understood by the agents. Further the system operator has to check the correctness of the requested action performed by the agent. These steps have to be taken to fulfil the job according to the framework and besides, to prevent impeachment by the agents.

To act under commercial conditions and according to the responsibilities the system operator needs to know the limits of the system, must learn risk management and might act at a higher risk, must be able to take over short-term operation planning tasks (e.g. re-scheduling, transaction management), needs to use new tools and must be trained to them.

Due to an increasing risk of outages, system operation becomes a more crucial job and restoration – which is in the new environment a parallel acting of several entities under commercial conditions – becomes an inter-company activity which has to be trained [9,10] together with the market operator and the agents physically linked to the power system. It is the responsibility of the system operator to provide such kind of inter-company training to defend the power system from outages and – in case this could not be avoided – to guarantee a fast restoration process. Additionally, all trading agents should be involved in these training actions to ensure a mutual understanding of system operation tasks and constraints affecting the energy trading environment.

Further improvements have to be made in system operation performance according to the trading environment and the available products. This is of course depending on the particular framework the transmission system is operated in, but changes of operation principles may become necessary. The introduction of new bid structures in the market environment for example has influence on the re-dispatch of the generators. General principles how to increase/decrease generator output, active power as well as reactive power, must be known by the system operator (e.g. Setpoint-control, Droop-control). Usually maintaining voltage profiles is defined as a local task to be performed by the affected agent (e.g. transmission, distribution agent). Clearly defined operation procedures must be stated by the system operator, otherwise as a result conflicting situations regarding system reliability may occur because reactive power handling with generators becomes a contrary task due to generators' physical relation of active and reactive power provision. This may lead to the installation of new devices (e.g. SVC or FACTS) in the transmission system which requires technical and operational training.

The incorporation of the demand side and interruptible customers into the market place requires a review of the power reserve management within the system. The system operator must be trained to the use of generators and interruptible customers for reserve management taking into account system constraints and time-constraints as well as commercial issues. Job requirements implement fast decision making and acting always according to the impacts on the transmission environment, according to the framework and the necessary as well as the requested information.

Another additional impact on the operator performance requirements is caused by the new organisation of the system operator entity:

- Establishing an **ISO**, the system operator is a new independent entity who has to co-ordinate one or more transmission agents and the thereto physically connected agents, as well as the responsibility for overall power system security and reliability. Operating personnel is usually recruited from transmission agents (e.g. the former traditional dispatch centre). They have to be trained to the new arisen tasks of overall system operation.
- Establishing a **TSO**, the system operator and its operating personnel is usually recruited from the former traditional dispatch centre, too (e.g. the national control centre). Besides the system operator's job also the job of the transmission agent is performed by the same personnel. This personnel has to be carefully trained to distinguish between system operator responsibilities/services and transmission agent services to avoid discriminative acting on the overall system.

The responsibility of the system operator requires transparent decision making and **information exchange** with all entities which also includes information exchange with non-technical personnel. Since the system operator is an independent entity and has access to very sensitive market information, operators must be

- trained to understand what is and what is not market sensitive information,
- instructed carefully to be able to exactly differentiate what information can be shared and what is confidential.

They must conduct themselves in such a manner that is beyond reproach. This privacy of information is very different from the operating environment before the unbundling of the electricity supply business where information was shared freely for the benefit of electric system operations. Strict adherence to a 'code of conduct' in daily operations is essential for the integrity of the system operator. The system operator must be aware that the information given to the market operator and the agents as well is used as signals in the

trading environment. Thus, the system operator personnel must be

- trained to understand the commercial environment and the principles of trading.
- furthermore trained to identify trading strategies of the diverse agents.

This requires further ongoing training if any significant changes of the trading environment are made. Introduction of changed bid-structures and therewith changed bidding strategies of the agents must carefully be observed and their impact on system operation must be preventively anticipated by the system operator personnel.

Human performance requirements also change in the commercial environment. One of the most important aspects of the changed environment is based on the market principle to be totally customer oriented.

As services and products of system operation and market operation evolve and extend, the mental pressure on the job of the system operator increases due to the higher workload. The market demands that the power system must be run closer to the operating limits for maximum efficiency, which means that every additional amount of power flow on a constrained transmission system means more profit for the energy traders. The operators must be trained to understand the marketing needs of the customers and at the same time, maintain a reliable power system. This balance between reliability and customer needs will place additional mental stress on the operators.

Another aspect that operators have to realise is that customer service means to change the traditional attitude of power system operation – the system is run by the operators the way they want – to a more focused customer-client relationship. Specialised customer relations training for all system operators is needed. This attitude learning process is very different from training traditionally used for system operators.

Due to the establishment and/or improvement of market operation as well the strong link between the trading environment and the impacts on system operation, an ongoing training of the operators in all entities is required. This leads in many cases – especially in regulated environments – to the establishment of quality standards and therefore measurable terms of quality for power system operation (e.g. Argentina, Iceland [11]). Here operator certification is also an issue of importance which will result in additional operator training requirements (e.g. maintaining the voltage profile in optimised limits).

4.2 Requirements on market operator

The market operator is in all cases a new entity to be established. The job of a market operator can be defined as the independent provider for the economic power trading environment for all participants as described in the market rules. Usual duties of a market operator are:

- Reception and acceptance of sale and purchase bids
- Day-ahead market and hour-ahead market (including control of each trading session)
- Matching process of buy and sell
- Matching results publishing
- Organised market overall prices
- Information about market evolution
- Market rules modification proposals
- Settlement and payments of the overall prices.

Besides these tasks the market operator is also responsible for keeping alive and running the whole computer system to assure that the participants can send the bids and retrieve the matching results information.

Basically, there are three kind of people working as a market operator, with high skills in several issues each:

- **Economists** who have usually university degree in economics, know market and trading principles and have comprehensive knowledge in trading issues.
- **Electrical power engineers** who know the physical characteristics of the electrical power systems and have got comprehensive knowledge in electrical power issues.
- **Support Staff**, especially telecommunication engineers who know and can manage the market operator's computer network and manage/configure/maintain the communication lines between the particular participants and the market operator system (this is the basic link in an internet-based system), and Computer engineers who keep the market operator's computer system running (e.g. database management, web management).

A market operator must be formed in the market rules not only in order to solve the participant troubles related with the application of these rules but even to have a whole idea about how the market works and a clear knowledge of all the processes involved in the market operation. Operating personnel of the market entity have to fulfil the job requirements mentioned above. Due to their different fundamental knowledge they must be trained in team-working to act as a market operator according to the market rules. Fundamental knowledge in economy and energy trading actions are also training needs. An understanding of the physical system environment, its capability and constrains, operation practises and an understanding of operation responsibilities is necessary due to the close interface to the system operator and the agents.

Further the market operator has to act in a non-discriminating and transparent way, too. The personnel has to be trained in the same manner as system operator personnel regarding these issues. The market

operator must be especially trained to the economic theory which the market is based on.

Good knowledge is required on

- Bids and bid types (e.g. sale, purchase, re-sale in a hour-ahead market)
- Bid structures and bid implementations, (e.g. power plant cost or distribution company serving cost is reflected in a bid).

Therefore, the market operator personnel must be trained to technically analyse the received bids and to verify their accordance to the market rules.

5. CONCLUSION

The unbundling of the electricity industry and its monopolistic structures results in a complex strongly commercial oriented business. The system operator is responsible for the physical transmission environment, whereas the market operator is responsible for the electricity trading environment. Both environments are linked by the settlement of imbalances, which also strongly determines the interfaces between these entities. To fulfil the new job requirements each entity has to review its (existing) training program and has to align its goals according to the tasks and duties which are defined in the framework (e.g. grid-code, co-operation rules and market rules). For all operators understanding of the interfaces between the entities as well as commercial theory and practise is a must and this has to be newly implemented in training.

Further it is highly recommended to all agents to get a mutual understanding of the whole commercial and technical system operation environment respecting today's physical and economic prevailing conditions including transmission system performance and fair trading practices.

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