POWER SYSTEM INFORMATION ISSUES ON A DEREGULATED MARKET ENVIRONMENT

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Abstract: The purpose of this paper is to analyze the role information plays in the new energy market structures that have been implemented worldwide. Economic incentive brings information to a strategic level for individual companies as well as for the whole sector. In this scenario, new concerns stem from the advent of increasing variety and complexity of information needs together with its crucial role in supporting decision. A brief analysis of the possible implications of extending open access to information is presented. Indications are made about the opportunity for fostering a whole range of service activities inside the power sector, related to value added information supplied by specialized agents. Enabling technologies are presented to help define applications that would provide more consistent and readily usable information.

Keywords: Information Exchange, Deregulation, Open Trading, SCADA/EMS, Control Center.

1. Introduction

Power systems have been operating under vertically integrated organizations on a monopolistic structure, where generation is not subject to competition. This situation has been changing in recent years due to a global move to deregulation and liberalization of the electric energy business. The basic strategy to implement such energy market is to unbundle generation from transmission allowing for the consideration of energy as a product and transmission as a service.

In the previous framework information was not regarded as a strategic resource, but as a by-product to be exploited mostly at the operational level. With deregulation, the role of information is being promoted to a strategic level due to its immediate potential of economic and technical impacts on decision making. Not only the availability and adequacy of information may affect the performance of individual companies and the sector as a whole but also social aspects have to be taken into account with increasing emphasis.

The mandate to open access to transmission by producers and consumers is expected to enable competition, but reflects in a trend to maximize the utilization of resources (transmission equipment). Those measures have as a consequence additional complexity of operations translated into an increase in the importance of control centers [1]. There is a clear need to complement control centers with a whole set of methods and applications for decision support. As the number of information sources may be large in this environment, notably at the ISO level for its central responsibility in the market, a very relevant an issue is what type of technology may be employed to summarize and extract information from large amounts of output data.

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In the new market scenario, regulatory action may establish a minimum amount of specific information to be exchanged among agents. Agents may have as a consequence an incentive to hide information from competitors, if they perceive a competitive advantage on this. Scarcity of information may even give rise to a new market of information as a commodity. The alternative would be to develop methods of inference or assessment of operating conditions in neighboring utilities. Nevertheless, information hiding may foster the appearance of a new agent – the technical information dealer

In addition to the issues above we propose and analyze what can be considered as a radical move in the direction of offering completely open and non-discriminatory access to all technical information provided by the different agents. Thus, competitive advantage would now be obtained not from the absence of information but from effective knowledge generated by exploiting information through innovative methods and artifacts.

2. Internal aspects

The first major aspect of the roles played by information in a deregulated environment concerns the internal issues that arise from new requirements and functions. In the following we consider two very well known agents and how they are affected: the Independent System Operator (ISO) and the Power Exchange (PX, also known as the Market Entity). Should these two be collapsed into one single body (the ISO) in specific models, the reasoning hereafter still applies.

2.1 The Independent System Operator

In the new model, the operating environment and resources needed for the ISO are fundamentally the same as of a traditional power-pool control center, with the addition of some functionality [2].

Reliability remains the main concern at the ISO level, and the main addition in terms of functionality is the calculation of Available Transmission Capacity (ATC) and Total Transmission Capacity (TTC) for reporting to the transmission customers through the OASIS system [3]. Spot prices may have to be calculated and reported to the PX. The ISO is also responsible for validating the day-ahead schedule submitted by the Power Exchange, and reporting back actual dispatched values for billing purposes.

Although the type of information handled does not change much from the old scenario, the requirements for accuracy, robustness and availability are more stringent, since there is a much more visible and direct economic impact of the operating decisions. Decision has to take into account tradeoffs between reliability and economy and must be well supported by information from specialized tools.

Performance of the state estimator becomes critical in this situation, both in terms of providing good information directly to the decision-makers and for the set of applications that are processed downstream and depend on the output of this application. There is a need for more robust algorithms as well as the possibility of operating on-step with the SCADA. There is opportunity for innovative research in this area

Performance in this case is not just dependent on algorithmic issues though, but also and maybe more so on the levels of observability throughout the network and on the quality of measurements as well. Adequate observability is a mandatory item and can be enhanced through judicious installation of additional measurements or Remote Terminal Units (RTU).

Quality of measurements must also be enforced in some cases even if it may demand replacement of transducers and associated hardware.

Additional quality may be obtained by employing innovations in measurements. With today's technology it is possible to obtain special measurements through the use of equipment connected to the Global Positioning System (GPS). GPS would also allow for an easy synchronization of RTUs to yield more consistent snapshots of the system and also the determination of the exact sequence of events that lead to a system-wide disturbance (a hard task with ordinary techniques)

2.2 The Power Exchange

In vertically integrated environments, accounting and billing used to be based on measurements made on tie lines connecting utilities. With deregulation this changes to measuring points of production and delivery, due to the separation of transmission facilities from generation and load. Specific requirements such as class of accuracy, type of measurement (energy) and periodicity of collection (hourly basis) set this type of data apart from those needed for reliability management in control centers. In many places around the world, data collection has been (at least partially) non-automatic, incurring in a long period of data collection and preparation for accounting and settlement. Those facts indicate the relevance of a dedicated real-time energy acquisition system, mainly to speed up the functions of data collection, preparation, accounting and settlement and a chain of related downstream applications. This function may be implemented as a simplified SCADA system both in terms of software and hardware. For example, PLCs may be employed instead of RTUs, since the number of measurements per site is usually very small. In addition, there is usually no need for special dedicated communication paths. Customized functions may be added to accommodate specialized data preparation to account for losses and metering positioning. All data may be subsequently stored on a relational database for ease of access by other functions. The SCADA processing is followed by applications that perform the day-ahead scheduling functions and other processing necessary for energy balancing.

If a separate acquisition system is not to be adopted, the Power Exchange has to obtain information on actual dispatch values and energy consumption from the ISO control center for billing purposes.

2.3 Other agents

As the deregulation movement breaks the vertical integration of utilities, the number of agents increases significantly, and so does the number of control centers necessary to supervise and control the existing facilities. As a basis, we may expect that every new generation, transmission or distribution company is going to have its own control center, which can be a simple SCADA, a complete EMS or something in between. With this respect information requirements and functionality seem to be already well established.

3. Information Exchange

Apart from the considerations on how to reap the benefits of information local to an agent, the exchange of information among players is quite characteristic of such a deregulated environment. This is due to de-verticalization, specific roles of the many types of agents and the economic meaning of having or not some pieces of information available.

3.1 Communications among control centers

In this regard, the only single point of special interest seems to be that, as the number of control centers may be quite large and increasing, so is the number of direct connections and interactions among them. In the special case of the ISO this is quite apparent, due to its centralized responsibility for the overall system operation. Typically there is an increase in the volume and complexity of transactions at the ISO level both with other control centers and with the Power Exchange.

The industry has reported some concerns with respect to the performance of protocols when the number of connections is large and complex transactions must be handled. Focus has been put on ICCP, which is currently the most important standard protocol for communication between control centers [4]. Although there has been significant advances in telecom technologies, uncertainties remain. Further investigation is needed with this respect.

3.2 Secure Access

One of the greatest challenges faced by providing a communication infrastructure to the power market is related to security issues raised when connection through the Internet is considered. The many potential benefits of being connected to a widely available network like the Internet may be hampered if security aspects are not addressed and solved properly. Constructing a private communication network may not be an adequate solution when facing the requirements posed by an open energy market where the number of agents may vary along time and new agents may come and go. This is especially the case of the OASIS function, as a provider of widely available information and services. A solution for the energy market could then possibly adopt the security approach that is already in use and is in the process of being standardized for electronic commerce, in the Internet.

With this type of connection, message contents are encrypted through digital keys. The burden incurred in violating this type of connection is proportional to the number of bits employed to construct the key. For strategic security reasons the US government blocked until recently the export of key of more than 40 bits, but it was not enough for secure e-commerce. Now with the release of keys up to 128 bits, security requirements for electronic commerce are finally met.

3.3 Information Hiding

In the new scenario, regulatory action does not demand that the whole information available at the agents be released for open use. The ISO is the only agent that has most of the data necessary for reliable operation, but it is not allowed by regulation to distribute some of the available information back to a non-originating agent. Within this framework, agents may have an incentive to hide information as much as possible from competitors, if they perceive a potential to generate competitive advantages. Competitors will then have to do their best to attempt to infer or assess the operating conditions of neighboring utilities.

Most important to note with respect to those competitive pressures is the fact that this may give rise to a new type of agent, that can be termed a Technical Information Dealer (TID, or broker). As industrial secrecy turns some pieces of information into a commodity to be traded at a price, the TIDs would have an opportunity to act in this niche. Lacking information may be obtained directly from the sources or may be the result of special techniques and applications especially developed for this purpose. Data mining techniques and forecasting models could typically be employed in order to provide good estimates for missing data.

What may differentiate one TID from another is a team of specialists equipped with advanced models, algorithms and tools, and accumulated capability in data handling, forecasting, planning and risk assessment. Their core business would be providing value-added information that may show high relative prices due to economic benefits accrued from its competitive advantage.

4. More Openness: the Operations Portal

With deregulation, information becomes a pervasive and prevailing element of the sector on both economic and technological grounds. Competition depends heavily

now on the availability of information and proper means to handle information with adequate tools. Information hiding can be used as a means to obtain competitive advantage indeed. What can be argued here is that such type of competition, instead of fully promoting a well-developed sector infrastructure, may, in fact, lead to market imperfections, hindering the emergence of novel businesses and opportunities.

Within this framework, competition would be based not only on non-discriminatory access to transmission facilities but also to information. Clearly we are not considering the public opening of contract values or monetary values which should remain under secrecy, but on technical data, necessary for the correct modeling of the whole process of the producing, transmitting and delivering energy, to give support to marketing decisions.

Let us examine what kind of implications may be anticipated on taking this new approach, with an initiative to open the whole set of technical real-time process data to all market agents. We term this an **Operations Portal (OP)**. The concept of a Portal is borrowed from the Internet and means an infrastructure (one or more web sites) that implement a whole set of information services related to the availability of data on the net. This portal would provide a whole bunch of information related services, besides open access to all process-related data, like search engines, operating instructions, post-operations reports, schedules, last-minute reporting of major events, results of studies, etc.

One way of bootstrapping the implementation of this augmented openness may be the straight distribution of the network state, as computed by a state estimator at the ISO. A topology model may be posted to the market, together with values of voltage magnitude and phase angle, generations and loads. This relatively small set of enables any agent to obtain information about any portion of the grid. The period of posting is one attribute to be determined, but with today's hardware and software it seems practical to foresee periods from 1 to 5 minutes. To facilitate access and handling to any agent this data could be posted as spreadsheet free-format data (ASCII) ready to be used at any desktop computer.

With this approach competitive advantage moves from the need to infer hidden information from competitors to the availability of new and novel techniques and technology for the fast exploitation of readily available data. This approach holds a great potential of leveraging both industry and R&D institutions.

The primary immediate consequence of this route, we think, would be the establishment of a whole new sector segment, of service activities composed by Information Agencies (similar in some way to the Technical Information Dealers) focused at offering value-added information on top of widely available data. Specialists armed with powerful methods, expertise, and computer tools, competing in terms of technology and knowledge, instead of simply providing summarized market information would form those agents.

In economics, the service sector has long recognized the role of information as a fundamental resource that permeates it, with the capacity of providing logistics to other economic sectors. Accordingly, the service sector has been acknowledged as an articulator of infrastructure required for a leverage of national economies.

Social aspects could also be fostered by the application of the OP approach. Market Monitoring by consumer representatives or Non-Governmental Organizations (NGOs) representing different interest in society would be extremely facilitated by this openness. For example, utilities applying decrease of voltage profile to force reduction in consumption by households during peak periods (to postpone investments or extra costs) could be easily detected.

The architectural support needed by OP may be similar to what is available today through OASIS systems. It can, in fact, encompass all OASIS functions, but the requirements may be more stringent, since the simple presence of a service sector has the potential of a burst in terms of exploitation of operational resources.

5. Information Handling: Prospects for Applications

The economic incentive to generate competitive advantage through more effective exploitation of information leads naturally to a focus on a new breed of computer applications and methods in a deregulated environment.

For decades now, the power systems area has witnessed an ever increasing accumulation of technical capability has been observed for decades now in the power systems area, as illustrated by the number of industrial and academic forums dedicated to computer methods and applications in power held internationally every year.

So far, progress has been constant with respect to numerical applications, notably those related to Network Analysis and Mathematical Optimization. Both classes of methods have been proposed for a number of applications in the new scenario [5]. Nowadays, a special focus has been cast on Real-Time Voltage Stability and Transient Stability Assessment for reliability purposes and congestion management. Optimization techniques like Optimum Power-Flow and its derivatives may have strong impact in the sector because they are able to combine reliability issues with economic aspects.

Practical uses of Artificial Intelligence (AI) aimed at solving different power system problems have been reported for a long time. A number of well established technical forums exist on this subject. On of the best examples of this type of application is Power System Restoration [6]. This area is expected to expand in the new scenario.

Another approach, presented with less emphasis in the literature but that holds a promise of being especially adequate for the new environment is the integration of AI techniques with numerical applications like those discussed above.

Connected with information handling, good prospects with respect to information handling come from the observation that algorithmic techniques are usually adequate when the kind of knowledge necessary is stable and well-formalized. On the other hand, if knowledge is subjective, fragmented or heuristic in nature, AI techniques may be most applicable.

In real life, though, most problems may be considered a combination of both. The strategy could then be to decompose a large problem into several sub-problems and to tackle them individually with the most suited approach. Some would be handled by network analysis techniques, other by optimization algorithms, yet another by AI techniques. This way, the overall strategy demands a seamless integration of numerical techniques with AI.

Another alternative comes from the fact that algorithmic applications usually produce large amounts of result data. The interpretation and summarization of this large volume of data into information of ready and practical use remains a task to the human element. This could typically be handled by AI techniques through the representation and exploitation of expert skills.

The effective integration of AI and numeric methods is as yet dependent on the type of problem to be tackled and remains as a research subject [7]. Nevertheless, market agents would have now strong economic incentives to invest in this area, if it can be perceived as an inducement to competitive differentiation.

6. Conclusion

In the previous monopolistic framework, information was not viewed as a strategic resource, but as a by-product to be used mostly at the operational level. With deregulation the role of information has raised to a strategic level due to its immediate potential of economic impact on the performance of agents.

The increase in complexity has raised the importance of control centers accordingly. There is a clear need to complement control centers with a whole set of methods and applications for improving the quality of information necessary for decision making.

Within this framework agents may have an incentive to hide information as much as possible from competitors, if they perceive a competitive advantage within this route. Competitors will then have to do their best to try to infer or assess the operating conditions of neighboring utilities, and clearly new methods and techniques are necessary with this respect. This may give rise to a new type of agent, which may be called a Technical Information Dealer.

As an alternative to information hiding, it may be interesting to implement open access to information similar to what is done to transmission, opening the opportunity for a whole new range of service activities inside the power sector. This approach has a great potential to leverage both the industry and research institutions and to foster advances in R&D, giving rise to a whole new information segment inside the power sector.

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