DOI https://doi.org/10.35219/rce2067053266

Main Risks and Mitigation Measures on the Current Structure of Electricity Market

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In the economic context created by the acceleration of global warming and globalization phenomena the operation of the power systems becomes more and more intricate and challenging, leading to an electricity market more complex and risky. The decisional process must be faster and the financial consequences may be very significant, thus a risk analysis is the most appropriate tool to identify the best set of decisions. In this paper, we propose the SMARTRADE software platform designed as a market simulator for the participants (mainly producers and suppliers or retailers) on the electricity market. A brief description of the facilities and options provided by the market simulator from the risks perspectives persuades the reader to go deeper into knowledge of this software.

Keywords: risks, electricity markets, software, platform, power sector, market simulator

JEL Code: C63, G32, Q41, L94

1. Introduction

The electricity market is one of the most important component of the nowadays power systems operation, because on one hand it ensures the necessary cash flows among the different actors, and on the other hand provides the required competitive framework for the various complex activities which form the today's power systems operation [1].

Following the unbundling, the electricity market diversified continuously becoming an intricate structure with components close related to the relevant aspects of the power sector, and economy in general. Accordingly, it is more and more challenging for the market participants to identify the proper long term strategies, due to a large (and increasing) number of variables that must be considered.

Global warming, increasing "globalization"[1] of the world economy, unforeseen events with global impact and others (year 2020 is an appropriate example in this respect) have a direct impact in the power sector. In this unstable environment, it is of outmost importance for a player or a participant on the electricity market to identify timely and accurate the most relevant risks he may have to face, and to develop and implement the necessary measures to mitigate these risks.

The concept of risk is very "popular" nowadays. In 2020, worldwide, despite the difficult economic situation generated by the pandemic of COVID19, more than 30 conferences dedicated to risks management have been organized so far.

Correctly identifying the risks, it is, of course, an especially important step in the process, but it is only the beginning or the iceberg tip. Normally, the mitigation measures are resource consuming and the resources are always limited. Therefore, it is mandatory a prioritization to handle the risks in the optimum way from the resources point of view vs. achieved results. Continuing on this line of thinking, establishing a list of priorities request not only a simple identification of the risks, but also a quantification.

Nowadays, a unique methodology and mathematical apparatus for calculating risks have not been established. The most usual approaches are: the identification of the risks with the frequency or probability of occurrence of the events, or a correlation by the instrumentality of a mathematical relationship in between the frequency or probability of occurrence, and the potential consequences of the event, quantified in money or other appropriate measurement unit.

The most suitable approach for quantification must be determined considering the features of the economic sector which is the subject of the risks analysis. In case of the power sector, according to [2], the most suitable approach is to consider a correlation in between the probability of occurrence of an event and the foreseen consequences of this event quantified in financial costs. As a result of this approach, each considered risk will have an associated unique value expressed in money. The bigger is the value, the more important is to mitigate this risk, so the priority list is starting with the highest values and ends with the lowest ones. This approach has the advantage that provides an adequate comparison term for the financial costs of the mitigation measures, necessary for the respective risk or risks.

For a participant to the electricity market, it is very often a matter of financial survival to be able to handle the risks timely and with the minimum volume of costs or/and resources. For this reason, the decision maker requires suitable computation tools for simulating different scenarios, analyzing the foreseen impacts and finally deciding the actions or strategies. Many software platforms have been developed [3], [4], [5] in this respect, but in almost all of them the issue for risks is treated shallow or not treated at all. Concerning the power sector, the SMARTRADE software platform that includes a market simulator [6] is one of the most advanced prototypes, from this point of view, providing clear views of the main risks and allowing the user to simulate different scenarios based on various risks values.

In the present paper, the authors are presenting the main risks that are included in the SMARTRADE software platform, how these risks are taken into account in the analyses and how the results should be considered in the substantiation of the decisions.

[1] According to the Committee for Development Policy (a subsidiary body of the United Nations), from an economic point of view, globalization can be defined as: "(…) the increasing interdependence of world economies as a result of the growing scale of cross-border trade of commodities and services, the flow of international capital and the wide and rapid spread of technologies. It reflects the continuing expansion and mutual integration of market frontiers (…) and the rapid growing significance of information in all types of productive activities and marketization are the two major driving forces for economic globalization."-source: youmatter.world

2. Risks Identification and Evaluation

"Risk-taking is the mother's milk of capitalism" – Wall Street Journal [7]. According to Thomas Sowell [7] "Perhaps the most important thing about risk is its inescapability. Particular individuals, groups, or institutions may be sheltered form risk – but only at the cost of having someone else bear that risk. For a society as a whole, there is no someone else. (…) Risks are not less pervasive today, but the perception of them, and an understanding of their inescapability, are not."

The most popular measures for mitigating the risks are the insurances policies provided by the insurance companies. In return for a premium paid on regular basis, the insurance companies assume the risks of compensating for losses caused by unwanted events. This approach is widely implemented in the economic sectors, but it is not so much developed in case of the electricity market because the electricity market itself is a rather recent sector in terms of market development and risks perception. For the time being, as respects the electricity market, it is more efficient to take specific financial measures for mitigating the risks.

The first and most important step is the definition of the risk concept, fine tuned for the electricity market features. According to [2], the most suitable approach for the risks on the electricity markets is described in the relationship below:

$$Risk\ of\ event = Probability\ of\ occurence^{T} \times Consequences\ of\ event \quad (1)$$

where:

$Risk\ of\ event$ – the value of risk attached to the event considered, expressed in money.

$Probability\ of\ occurence^{T}$ – the probability of the event occurrence in a determined period "T", with no measurement unit.

T – the period used for the evaluation of the probability of event occurrence, expressed in years.

$Consequences\ of\ event$ – the consequences of one occurrence of the event, expressed in money.

Usually, all possible consequences of the unwanted events may have an equivalent in money, with a noticeable exception: loss of the human life. If this is the case, the mitigation measures must be implemented no matter the costs.

The value of the risks computed in line with relationship (1) provides a reliable information concerning the potential financial threats attached to the event in cause, it is easy to understand, and it provides an adequate comparison element for the cost of the mitigation measures. For example, if the costs of the mitigation measures are higher than the value of the risk, for a period of 10 years (or other), it may be recommendable to not implement the mitigation measures at all. The accuracy of the results obtained using the relationship (1) are very much dependent to the accuracy of the assessment of the two components: *probability* and *consequences*.

The value of the occurrence probability must be assessed considering a determined period. Considering the probabilistic nature of this item, it is recommendable to select periods of one year or more. The longest is the period, the more accurate the probabilistic calculations will be. In certain situations, especially when the duration of the analyses is relatively short (one year or even less), it is also recommendable to assess a margin instead of a unique value, for a better understanding of the potential evolutions. In case of long-term analyses (ten years or more), the assessment of a margin may not be useful.

An accurate assessment of value of the consequences requires an intricate analysis because it involves not only the costs of equipment, costs of electricity, and other costs, but

also the variation of these costs along the period considered for the analyses. Obviously, for the analyses performed on short term (around one year), it is far more less difficult than for the analyses performed on mid and long term (five years and more). In contrast to the probability of occurrence, for the assessment of the consequences, it is not useful to have a margin in case of analyze on short term, but it is recommendable to have this approach for the assessments and analyses on mid and long term.

The calculation of risks described by the relationship (1) is particularly suitable for the power sector features: the equipment outage rate has a reduced value and is constant in time, the outages are independent one to another, the consequences of the events do not involve loss of human life and they are easily converted in money. Another advantage of the above-mentioned approach used for computation of the risks is the possibility to integrate the results in a more broader Cost Benefit Analyses (CBA) in order to substantiate very scrupulously, the decisions for mitigating the respective risks.

3. Main risks associated to the participation on the electricity market

Currently the electricity market is structured in four main independent markets as follows: wholesale bilateral market (BWM), day ahead market (DAM), electricity balancing market (BM) and ancillary services market (ASM). BWM is different to the other three as regard the negotiation principles, contract types and transactions duration.

The risks associated to each market are slightly different, but three main common categories may be identified:

- Risks associated to the price's variations,
- Risks associated to the finalization of the transactions,
- Risks associated to the compliance with contractual values.

While the first type of the risks is a usual one, common to all markets, the second and the third ones are specific to the electricity markets. The mitigation measures are different for each type of risks and in Paragraph 4 of this paper, the facilities included in the SMARTRADE software platform are described.

3.1. Risks associated to the price's variations

Prices are the most important issue of the free markets as "Prices formed a worldwide web of communication long before there was an Internet. Prices connect you with anyone, anywhere in the world where markets are allowed to operate freely, so that places with the lowest prices for particular goods can sell those goods around the world, and you can end up wearing shirts made in Malaysia, shoes produced in Italy, and slacks made in Canada, while driving a car manufactured in Japan, on tires produced in France." [7]. The most important factor that determines the variation of the prices on the electricity market is the ratio between demand and offer. The electricity producers participating to the market have different cost of generation based to the technology and/or type of fuel they are using, and they are competing each other for supplying the demand, on an hourly basis, without any pause whatsoever. If a significant event occurs with respect to either party (demand or generation), the price level will be impacted accordingly. This strong correlation is a feature of the electricity market and it is generated by the reduced capabilities for storage (this situation is about to change due to the latest breakthroughs in the batteries technology, but not in the near future).

This type of risks is associated to the transactions on all the above-mentioned electricity markets, but in different degree. BWM is characterized by long term contracts with prices and volumes fixed to some extent, therefore the impact of this risk will be limited (most probably not totally removed). In case of an outage of a large electricity generation unit, the electricity price will most surely go up significantly because the generation units used to replace the damaged one have a higher production cost, therefore a higher selling price. The

impact on prices has the same pattern in case of an outage of a large consumer, but in this case the prices will go down because there will be too much electricity and the producers will face a price reduction.

3.2. Risks associated to the finalization of the transactions

In case of BWM, this risk has no significance because the transactions (contracts) are completed for long term and they are including all the details regarding the electricity quantities and prices.

DAM, BM and ASM are operating according to the stock markets principles and rules. Therefore, the risk associated to the failure of the transactions or their finalization is significant. This risk is associated with the situation when an offer is made on the market (for buying or for selling), but it is not accepted due to the selling of buying price level.

For proper understand the potential impact of this type of risks, it is recommended to quantify them using the relationship (1) presented in this paper in Paragraph 2.

3.3. Risks associated to the compliance with contractual values

This type of risks is specific to the power sector and electricity market, and they may materialize both in normal operation condition of the power system and in case of outages. In normal conditions, the sources of this type of risks are mainly the consumers and the electricity generators powered by not controllable energy sources: wind, sun (photovoltaic technology) and micro – hydro powerplants. In case of outages, any of the electricity market participants are exposed to this type of risk.

In contrast with the previous mentioned types of risks, the transactions concluded on BWM are more exposed to this type of risks as compared with the ones finalized on the other three electricity markets. This is because the duration of the transactions / contracts on BWM are usually starting with one year and may go up to five years or even more.

Similar to the types of risks presented in the previous paragraph, it is recommended to quantify the risks associated with the non-compliance with the contractual values using the relationship (1) presented in Paragraph 2.

4. SMARTRADE software platform

A software tool for simulating the participation of a producer / supplier / trader / dispatchable consumer on BWM, DAM, BM and ASM aims to identify how decisions regarding the prices or quantities offered for transactions and risks associated with these markets may influence the revenue of a participant.

In order to meet the present needs of the market players, the authors of this paper have developed a software platform for simulating the possible electricity market transactions, for each of the major players: generators, suppliers, traders, and end-users. The simulations are based on the electricity market structure currently implemented in Romania. The Romanian electricity market is a mature one after decades of operation, and there are reasonable grounds for it to be considered as representative for EU countries. Of course, within EU member states, there are more sophisticated electricity markets, such as: Germany, France, or Ireland, but on the other hand, there are states where the electricity market is just beginning to develop. Also, the Romanian electricity market might be considered a good example, as it follows the integration at regional level [9].

As compared with other similar software products existing on the market [3], [4], [5], SMARTRADE market simulator includes facilities to assess the value of the risk for each electricity market and for all electricity markets combined for the entire analyzed period.

Figure 1 below presents the use case of the SMARTRADE market simulator [8].

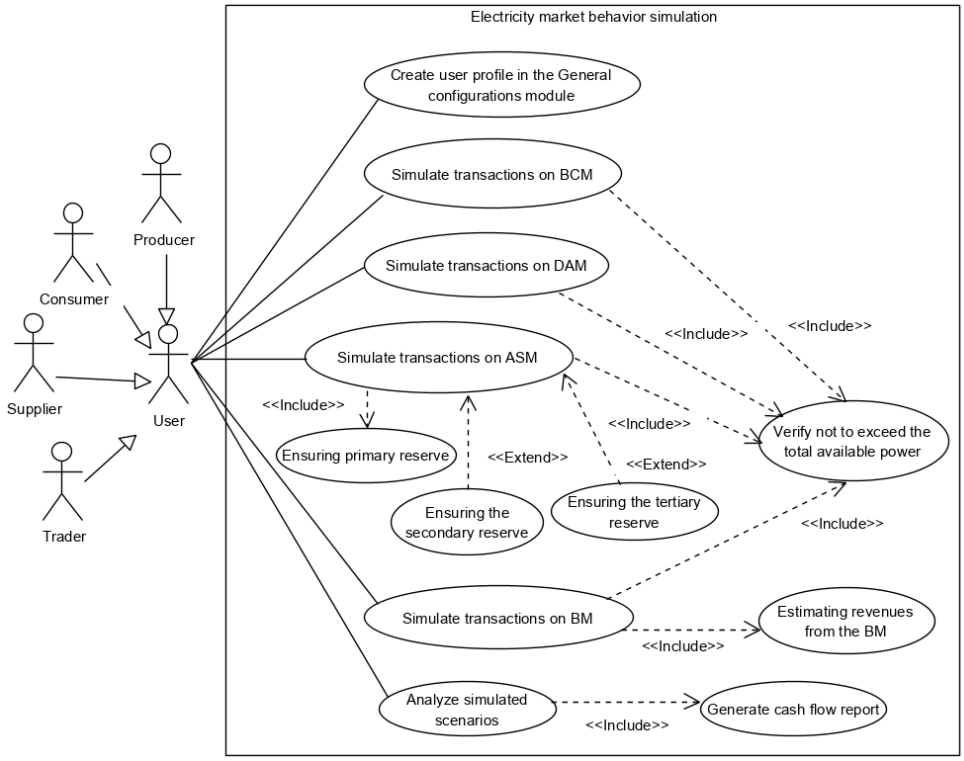

Figure 1 – Use case of the market simulator

The platform provides useful tools to analyze and simulate various market evolutions, as a solid base for making the right decisions in time. For each of the electricity markets (BWM, DAM, BM and ASM), the most relevant risks are defined and quantified. Meanwhile, it is designed to be user-friendly and to provide a large set of options, covering almost all the possible operational situations an electricity market participant may be challenged with. In line with relationship (1), the software provides to the user the tools for assessing both mathematical components: probabilities and financial consequences. In Figure 2, the interface of the module performing the simulation of the transactions on BWM is presented [8].

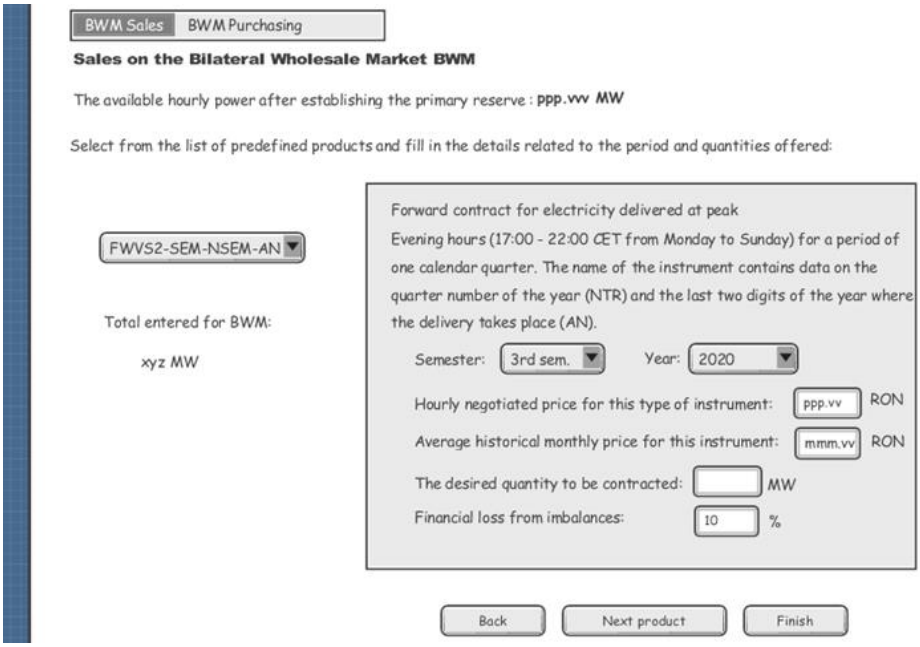

Figure 2 – Interface of the module for simulating transactions on BWM

Coming to meet the needs of the user, SMARTRADE market simulator is providing statistical information regarding the prices and electricity volumes traded on the Romanian BWM in the last five years. The registered prices are related only to the finalized transactions (do not include the offers not accepted). Based on this information the user may develop different scenarios for price variation, identifying the potential impact, and the most appropriate mitigation measures, and recommending a value on this basis. This approach is used for all the other electricity markets simulations on: DAM, BM and ASM.

The results obtained at the end of the simulation include the estimated income, estimated cost, average market price, traded energy, and the related risk level associated with a certain scenario of trading. The user has the possibility to develop a set of scenarios, describing all the relevant evolutions on the electricity market. For better understanding of how SMARTRADE facilities can be used to estimate the level of risk of the set of transactions included in a given scenario, the authors recommendations regarding the level of frequency (probability for a determined period) for the main events with a negative impact on the respective electricity market are presented in Table 1. These recommendations are based on the statistical analysis of the offer acceptance in the last five years on the Romanian electricity market. Then, the total risk associated with a scenario can be calculated as a weighted risk.

Table 1 – Recommended values for transactions failure frequency per year

No.	Electricity Market	Events with Negative Impact	Frequency [%]
1	BWM	Risks associated to the compliance with contractual values	5
2	DAM	Risks associated to the finalization of the transactions	20
3	ASM	Risks associated to the finalization of the transactions	70
4	BM	Risks associated to the price's variations	50

5. Conclusions

Power sector is an economic sector where the principles of the free market have been implemented rather recently (only few decades ago). Electricity market has had the role to implement the rules of competitiveness, and to ensure a proper support for the commercial and financial aspects associated to the power systems operation. Initially the structure of the electricity market was very simple, but in time this situation has changed and nowadays there are four main components: BWM, DAM, BM and ASM [9]. Each of the four markets has its features, organization and market rules, independent of each other. In these conditions, for a participant on the electricity market, it is rather difficult to identify the best set of decisions for achieving the maximum revenue (or at least close to it) considering a determined volume of resources (funds, fuel stocks, installed power, duration, etc.). Risk analyses are a powerful tool to substantiate the decisions in a such intricate and unstable environment of electricity markets. For the risk assessment, in the present paper, we proposed an approach especially suitable for the features of the power sector: events with very low probability of occurrence, rate of occurrence constant in time, independent events, and consequences of the events facile to be equivalenced in money. The methodology for risk analyses together with other useful analytic tools are implemented in SMARTRADE software platform – market simulator. The platform is designed to be user-friendly and include databases with historical information regarding prices and traded volumes with the aim to fully support the user in the decision-making process.

Acknowledgments:
This paper presents the scientific results of the project "Intelligent system for trading on wholesale electricity market" (SMARTRADE), co-financed by the European Regional Development Fund (ERDF), through the Competitiveness Operational Programme (COP) 2014-2020, priority axis 1 – Research, technological development and innovation (RD&I) to support economic competitiveness and business development, Action 1.1.4-Attracting high-level personnel from abroad in order to enhance the RD capacity, contract ID P_37_418, no. 62/05.09.2016, beneficiary: The Bucharest University of Economic Studies.

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