

The role of distribution system operator in the context of energy security – the case of Poland

Streszczenie. W artykule przedstawiono rolę operatora systemu dystrybucyjnego w aspekcie bezpieczeństwa energetycznego. Przeprowadzono analizę w obszarach: prawnym, technicznym i ekonomicznym oraz dokonano oceny możliwości i skuteczności stosowanych w Polsce rozwiązań w procesie zapewnienia bezpieczeństwa energetycznego. (Rola operatora systemu dystrybucyjnego w kontekście bezpieczeństwa energetycznego na przykładzie Polski).

Abstract. This paper examines the role of distribution system operator (DSO) in the context of energy security, using Poland as an example. Analysis of the role of DSO in ensuring energy security in legal, technical and economical domain is shown. Moreover, the evaluation of possibilities and effectiveness of solution applied in Poland for DSO from a point of view assurance of energy security is described

Słowa kluczowe: bezpieczeństwo elektroenergetyczne, system elektroenergetyczny, operator systemu dystrybucyjnego.

Keywords: energy security, power system, distribution system operator.

Introduction

A country's energy security is the condition of its economy, allowing it to meet the consumers' current and long-term demand for energy in a technically and economically feasible way in compliance with the environmental requirements.

The distribution system operator (DSO) plays a important role in ensuring national energy security. DSO handles electricity distribution and is responsible for network traffic in the distribution system, the current and long-term operational security of the system, the operation, maintenance, repairs and necessary expansion of the distribution grid, including its connections with other electric power systems (art. 3.[1]).

The level of national energy security depends on many factors, including the state of local energy security. Distribution system operators (DSO) and the distributed renewable energy industry sector play the key role in ensuring energy security [7].

National legal regulations concerning energy security are contained mainly in the Energy Law which is the most important and key act for the functioning of the power energy sector in Poland [8]. Detailed executive acts, in the form of orders issued by the Ministry of Economy or the Council of Ministers accompany the Energy Law. This includes a group of orders particularly relevant to national energy security, comprising: system orders [2], tariff orders [3] and [4], orders concerning electricity supply and consumption curtailments, and other orders.

Legal domain

The activity of DSO as the most important entity in the energy security area is defined by the Energy Law. DSO's range of responsibility is significantly lower than transmission system operator (TSO) but to a large extent it covers elements directly or indirectly connected with national energy security [8].

According with art. 9c.it.3 [1], DSO is responsible for:

- operation of the distribution grid in an effective manner, maintaining the required reliability of electricity supply and the quality of supply as well as coordinating the operation of the coordinated 110 kV grid in cooperation with the TSO;
- the use, maintenance and repair of the distribution grid in a way that ensures the reliability of the operation of the operation of the distribution system;

- ensuring the expansion of the distribution grid and – where applicable – expanding the intersystem connections within the area of their operation;
- cooperation with other systems operators or energy enterprises to ensure a consistent operation of electric systems and their coordinated development, as well as a reliable and effective operation of those systems;
- managing the generating units capacity connected to the distribution grid, except for the using the generating units of capacity of 50 MW or higher connected to the coordinated 110 kV grid;
- balancing the electricity system, except for the balancing of the ongoing electricity demand with the supply of electricity in the national electricity system, the management of the system restrictions and conducting a settlement system with the system users;
- managing the electricity flows in the distribution system and cooperating with TSO with respect to the management of electricity flows in the coordinated 110 kV grid;
- purchasing electricity in order to compensate the losses suffered in the distribution grid during the distribution of electricity in that grid, as well as using transparent and non-discriminative market procedures while purchasing that energy;
- cooperation with TSO in developing action plans for large-scale power system failure scenarios and the plans of contingency reconstruction of the system after such a failure;
- planning the development of the distribution grid with a consideration for the projects related to energy efficiency, energy demand-side management and the development of the generating capacity connected to the distribution grid;
- complying with the terms of cooperation with TSO with respect to the operation of the coordinated 110 kV grid;
- developing a normal transmission grid operation system and cooperating with the adjacent distribution system operators and in cooperation with TSO with respect to the development of the normal grid operation system for the coordinated 110 kV grid.

The distribution system operator like TSO has the duty to maintain, both short- and long-term, the capability of the equipment, installations and networks for the continuous and reliable supply of electricity conforming to the quality requirements in force [8].

The duty to maintain the capability of the equipment, installations and networks for the continuous and reliable supply of electricity specifically relates to:

- the proper control of traffic in the grid,
- looking after the condition of the network infrastructure (operation, maintenance, repairs),
- taking care of the expansion of the distribution grid and the intersystem connections,
- the adaptation of the network infrastructure to the changing (locationwise and structurally) energy demand and power generation sites.

The carrying out of the main tasks and duties relating to the operational security of the electric power system or the security of power supply is monitored and checked by the President of the Energy Regulatory Office (ERO). For the improper performance of the tasks and any failure to carry out the statutory duties the distribution system operator can be fined by the President of ERO and in the extreme case, DSO's licence can be revoked.

Technical domain

The activity of DSO in the technical domain in the energy security area is highly complex. It includes various elements connected with, among others, network infrastructure, technical standards, cooperation with TSO and other distribution system operators, system balancing and distribution system planning.

According to article 4 of the Energy Law, DSO has the duty to look after the condition of her/his own network structure in order to be able to supply energy in a continuous and reliable way and in conformance with the quality requirements in force. This constitutes an important element of energy security in the short-term. The improper operation or neglect or reduction of maintenance and repair of the network infrastructure by the operator increases the probability of failures and power cuts. The regulations of art. 4 of the Energy Law concern also long-term energy security with regard to replacement and development investments in the electric power distribution area. Neglect to develop the distribution network and intersystem connections and to adapt the network infrastructure to the changing (locationwise and structurally) electric energy demand and power generation sites leads to the inefficiency of the electric power system in the future.

DSO is obliged to meet the minimum distribution system maintenance and development requirements. The extent of undertaken measures and investments should not be smaller than the minimum below which the condition of the network infrastructure deteriorates and reduces DSO's ability to supply energy in a continuous and reliable way and in conformance with the quality requirements in force.

Unfortunately, currently the distribution grid in Poland is undercapitalized which results in its poor technical condition, which, in turn, may create barrier to economic development, particularly for some areas of the country.

The principal document, regulating the technical standards area in distribution system, is the Distribution Network Operation and Maintenance Instructions (DNO&MI). It specifies the conditions for the use of the distribution grid by the system users and the conditions and way of conducting traffic and operation, and planning the development of the networks [5,6]. The instruction was intended as a technical-economic document defining the rights and duties of the distribution grid users.

The instruction contains, among other things, system operational security regulations specifying:

- the principles of connecting generation equipment, end-consumer equipment, intersystem links and direct lines;

- the technical requirements for equipment, installations and networks, including the necessary support infrastructure;
- the principles of cooperation between electric power system operators, including with regard to the coordinated 110 kV network;
- the principles and procedures for interchanging information between power utility companies and consumers;
- criteria for electric power system operational security;
- electric energy quality parameters and quality standards for servicing system users (art. 9g. it.4. [1]).

The distribution network operation and maintenance instructions consist of two parts: a general part containing the terms of distribution grid use, traffic, operation and development planning and a detailed part containing system balancing and system constraints management.

The general part of DNO&MI contains the procedures and ways of performing actions connected with grid traffic and operation, covering:

- grid technical specifications;
- technical requirements for networks, equipment and installations to be connected to the grid;
- the way of and procedures for connecting and disconnecting installations and networks to the grid;
- the range of periodic surveys and inspections of the technical condition of the grid and the equipment, installations and networks connected to it;
- the procedure to be used in cases when electric power supply continuity may be disrupted or a failure may occur in the electric power system;
- procedures for supply interruptions and load curtailments;
- the way of conducting grid traffic (e.g. grid operation programming, grid traffic documentation, the range of traffic and operational cooperation with the equipment, installations and networks connected to the grid);
- the planning of grid development and cooperation;
- systems and forms of collecting, transferring and interchanging information.

The detailed part of DNO&MI contains, among other things, the conditions which must be met with regard to system balancing and system constraints management, the procedures for system constraints management, including the system constraints cost accounting, and the procedure to be used in electric power supply security emergencies.

DNO&MI is currently in its entirety approved by the President of ERO, and the system users, including the consumers whose equipment, installations or networks are connected to DSO's grid are obliged to comply with its terms, requirements and procedures and ways of interchanging information.

In order to ensure the safe operation of the electric power system it is necessary to specify, among other things, the terms of cooperation of DSO with TSO with regard to network traffic, the management of flows and generating units' power and emergency procedures. TSO plays the key role in this area, defining, among other things, coordinated operation configurations for the 110 kV network and the way of cooperating in planning and conducting traffic in this network. Moreover, TSO specifies the way of cooperating with DSO in: planning the technical means to meet the demand for electricity in the electric power system, developing plans for preventing and eliminating failures and hazards to the safe operation of the electric power system and rebuilding the system, planning the development of the grid and drawing up plans to meet the current and future demand for energy in one's own operating area, etc.

DSO ensures cooperation with producers whose generating units are connected to the distribution grid and to the coordinated 110 kV network, to an extent necessary for the safe operation of the electric power system and for assuring the power of the electric energy sources. DSO specifies, among other things, the basic requirements for distributed generation sources, include: technical and operating requirements ensuring electric power system operational safety, requirements for maintaining electric energy quality parameters at the place of connection and providing the possibility of taking measurements needed for network operation and accounting [5,6].

Electric energy supply continuity means the capability of an electric power network to ensure the supply of this energy with a specified quality and reliability. This capability is determined by, among other things, such system operator activities as hourly electric energy demand and supply balancing or providing system services.

In the context of energy security, grid development planning by the distribution system operator is her/his major duty. DSO draws up development plans, concerning the satisfaction of the current and future energy demand, for a minimum period of 3 years (art. 16. it.1[1]). The development plans drawn up by DSO cover: the anticipated range of electric energy supply, undertakings aimed at modernization, expansion or building of distribution networks and possible new electric energy sources, undertakings rationalizing the consumption of energy by the consumers, the anticipated way of financing investments, the anticipated revenues needed to carry out the plan and the anticipated investment schedule.

Economical domain

DSO bears economic liability for electric power security, stemming from mainly distribution service provision contracts or from a comprehensive contract's part concerning distribution services. The terms and conditions for the provision of distribution services by DSO are specified not only in the contract, but also in the licence, the tariff and DNO&MI. The latter is also a part of the electricity distribution service provision contract or the comprehensive contract.

Distribution service provision contracts include clauses concerning electric energy quality standards and supply reliability standards. Depending on the consumer's demands, it may also include clauses concerning elevated supply reliability standards. Noncompliance with the standards results in the economic liability of the operator and entails giving the consumers (on their request) price reductions and discounts in the amount specified in § 37 [3] or in the distribution service provision contract or the comprehensive contract. Moreover, such contracts may include additional clauses concerning the operator's economic liability (contractual fines, etc.) for nonadherence to the terms of the contract or for its improper implementation.

The standard electricity supply reliability parameters for each electricity supply point include: the allowable duration of a supply interruption and the total annual time of supply interruptions. The interruptions may be long and very long, scheduled and unscheduled (failures). The parameters are specified in system order [2] for users connecting on LV or in the contract for others. The exceedance of the durations results in the necessity of paying rebates amounting to the fivefold increased price for electric energy for the period in which the interruption in the supply of this energy occurred (§ 37 it.2 [3]).

In energy supply security emergencies not only the contract concluded with a consumer but also the provisions

of the Energy Law and its executive acts [2] and [4] have a bearing on the economic liability of the system operator.

DSO does not bear economic liability for the consequences of load curtailments introduced in the normal mode or in accordance with order [4], provided that the proper procedures are adhered to and proper measures are taken, with utmost care, by the system operator. All these procedures and measures should be consistent with suitable clauses in DNO&MI.

In accordance with § 35 it. 6 of order [2], in the case of a failure in National Energy Power System (NEPS) or a risk of such a failure or an electric power system security emergency, the operator may cut off equipment, installations and networks in the mode specified in DNO&MI, irrespective of the supply interruption or emergency cutout durations specified in the system order [2] or in the contract.

Load shedding by the operator in the process of eliminating a network failure, a system failure or a hazard to NEPS is permissible when the situation justifies such measures.

DSO has an obligation to take necessary measures to ensure the continuity of electric energy supply and to prevent failures as well as to limit the effects and duration of such failures in collaboration with the producers and the end users connected to the distribution grid and with TSO and other distribution system operators. TSO fulfils a superior role when doing the measures.

The Energy Law defines the principles concerning the liability of the system operator for any damage suffered by affected electric power system users connected to the national electrical power grid, as a result of the measures taken to eliminate: a hazard to electric energy supply security or failures in electric power system.

In the case when damage arose as a result of force majeure or solely through a fault of the aggrieved party or a third party, the system operator does not bear any liability. Whereas when damage arose as a result of circumstances for which the system operator bears liability or in the case of negligence in assessing the validity of introducing load curtailments, the operator is limited liable for damages.

Analysis of solutions for electricity supply security emergencies

The effectiveness of the legal, technical and economic solutions concerning DSO is of big importance to the operational security of the distribution system and so to operational security of NEPS and in consequence to the country's energy security. It is particularly important to verify the solutions in the case of failures resulting in electricity supply security emergencies.

In the light of the national legal regulations, when an electricity supply security emergency arises, DSO undertakes, under the supervision of TSO and in collaboration with TSO and other appropriate distribution system operators and in collaboration with all important the distribution system users, all possible measures using all available means to eliminate this hazard and prevent its negative effects. If it is necessary to introduce constraints in electricity supply and consumption than they should cause the least disturbance in the operation of the electric energy market and should be used to the extent necessary to restore the proper operation of the electric power system and be based on the criteria adopted for the current balancing of the electric power system and for managing system constraints. Moreover, they should be agreed on with the proper system operators in accordance with the contract provisions.

Procedures and duties for system operators and users in the case an electricity supply security emergency have been introduced in the last change of the Energy Law.

DSO has a duty, for given order by the proper TSO services, to:

- start up, shut down, change the load of or disconnect a generating unit, which is not a centrally controlled generating unit (CCGU), connected to the distribution network in his/her operating area;
- reduce the amount of electricity drawn by the end consumers connected to the distribution network in his/her operating area or to interrupt electricity supply to the necessary number of end consumers connected to the distribution network in this area.

In such situation DSO's dispatching services give orders to the end consumers connected directly to the distribution network in his/her operating area to reduce the amount of drawn electricity or to disconnect consumer equipment or installations from the network, in accordance with the schedule of constraints. In the period when the operations are executed the system users are obliged to obey the orders given by DSO's dispatching services, provided that the execution of the orders does not pose any life or health hazard.

During an electricity supply security emergency the switching instructions given by TSO's dispatching services are superior to the dispatching instructions given by DSO's dispatching services.

In the period when an electricity supply security emergency occurs DSO may impose constraints on the provided electricity distribution services to an extent necessary to eliminate the hazard to electricity supply security.

The costs borne by the system operator in connection with the necessary measures taken to eliminate the hazard to electricity supply security constitute legitimate operational costs.

The solutions adopted for DSO in electricity supply security emergencies are proper and effective. In order to ensure electricity supply security and take proper and coordinated measures in an electricity supply security emergency, relations between DSO's dispatching services and TSO's dispatching services, electricity producers and the end consumers connected to the distribution network or to the coordinated 110 kV grid in DSO's operating area should be precisely defined. The superiority of the orders given by TSO's dispatching services should be clearly stated. A hazard to electricity supply security makes it necessary for DSO to take several measures in order to eliminate it. The measures can be questioned by the distribution system users since they put a strain on the proper services of the utility companies and on the consumers and have serious technical and economic consequences for them. Therefore all the system users should be obligated to carry out the instructions given by the proper dispatching services of DSO in a situation when this does not pose an immediate hazard to life or health. For DSO the implementation of the measures entails considerable expenditures, which should constitute his/her legitimate operational costs.

Conclusions

The distribution system operator is important entity in the sphere of national energy security. His/her range of responsibilities is wide and to a considerable extent covers elements connected directly or indirectly with national energy security. DSO also plays a important role in the prevention and elimination of failures and hazards to the safe operation of electric power system. Therefore the

effective and efficient performance of the distribution operator's tasks and duties relating to the safe operation of electric power system is of primary importance.

The distribution system operator has the duty to maintain, both short- and long-term, the capability of equipment, installations and networks to supply electricity in a continuous and reliable way while meeting the quality requirements in force. This is vital for the operational security of electric power system. Improper operation and abandonment or curtailment of maintenance and repairs of the network infrastructure by the operator increases the probability of a failure and nondelivery of electricity to the consumers. Failure to expand the distribution grid and to adapt the network infrastructure to the changing (locationwise and structurally) demand for electric energy and its generation sites leads to the inefficiency of the electric power system in the future.

From the distribution system operation security point of view, the distribution network operation and maintenance instruction is the most important document developed by the distribution system operator. It is crucial to define the responsibility of the system users for compliance with DNO&MI, and the range of the latter's regulations. The instruction defines, among others, the duties of network users, the proper performance of which greatly affects the operational security of electric power system.

The legal solutions used in Poland enable DSO to take effective and efficient measures in electricity supply security emergencies.

The last change of the Energy Law, passed 8.1.2010 and operative from 11.03.2010, improved significantly legal solutions in domain of energy security for distribution system operator from point of view effectiveness and efficiency.

LITERATURE

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