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Tarkalanov Yuriy*,
Beleliev Dimitar**

*Professor PhD, rolt@abv.bg, University of National and World Economy, Sofia, Bulgaria

**Doctoral candidate, beleliev@dibel.bg, Sofia, Bulgaria

Methodology for evaluation of energy security

Summary
The report describes methodology for evaluation of the energy security through analysis and evaluation of the risks for the energy system and socio – economic relations.

Keywords: energy security, methodology, risk, identification, analysis, evaluation

Axiomatics of the energy security

The term energy security" appears and is being established in the last quarter of the 20th century, and continues to be an important item in the beginning of 21st century.

Several aspects are being considered:

- Operational and technical reliability of the energy system, of the equipment and personnel.
- Stability, reliability and continuity of deliveries of enery resources, in the required volumes.
- Effective, economically justified energy supply, on reasonable prices, etc.

The term gathers technical, political, economical, social, ecological and other aspects. National and international dimensions are formed as well. The term itself is now considered widely enough in economical and political aspect. It is a part of the widely acknowledged understanding of security, in which, along with the military and military – political aspects, we find economical, social, humanitarian, ecological, informational and other aspects as well. The representatives of the Copenhagen School (members of which are Barry Buzan, Ole Weaver, Jaap de Wilde, Lothar Brock, Marc Levi, Charles Schultz and others) have a great contribution to this. In theoretical elaborations the energy security is considered as a sub-type of the economical security.

For evaluating security, including energy security, different categories are being used, such as danger, threat, risk and vulnerability. There is no unified position in specialized literature and among experts, when it comes to the content of the terms. For the purposes of this report and with no claims for comprehensiveness, we will use the following terms.

Danger is the most general term, accepted as the negative feature of the living and non-living matter to cause harm to the people, environment and material property. [1]

When it comes to social and socio-economic systems, danger is considered as the deviation from the direction of movement, a change in the state; as a possible influence on an element or a connection between elements, capable of violating the current function of a system and its development [2 p. 34].

The high state of uncertainty and hypothetical influence on time and dimension are typical for the term.

Threat is considered in a more specific aspect, as realization of danger with concrete sources/carriers. Considering the given subject of this elaboration – the energy security, threats can be determined as events with short term or long term character, which destabilize the operation of the energy complex, limiting or violating the power supply, leading to breakdowns and/or other negative consequences on the energy sector, economics and society.

Vulnerability is a feature of objects – the ability to change their state as a result of a negative influence coming from a dangerous events/phenomena. In the risk theory vulnerability is connected to the "weakness" of the system, a shortage of resources, and lack of control on certain processes.

In general risk is considered as the possibility of occurrence of negative consequences /harm, losses/ as a result of the influence of negative (dangerous) events. In theory, it can be said that the risk connects danger/threat and the system's vulnerability, considering the uncertainty in realization of the negative influence and size of harm. [3, 4]

The complex character of energy security, which relates to different aspects of the existence and evolution of nations and international community, predetermines the different approaches for its evaluation. The specifics of energy as an economic branch, determine the usage quantity methods. The evaluation of energy security as a condition, that determines the realization of public and personal interests in the energy sector requires the application of quality methods as well. Because of the aforementioned, both quality and quantity methods are being used in the applied approaches, as the accent is on the latter.

Quantity methods for evaluation of energy security

At the base of mathematics – statistics methods we find the so called indicative approach, in which the following stages are achieved:

1. A system of references and relevant numeric indicators is developed.
2. Limit values of the indicators are determined.
3. The limit values are such values, the crossing of which (in increasing or decreasing direction) indicates the development of negative processes and dangers, which could result in harm of the energy system, and energy security respectively.
4. The ranges, defining the different conditions of the energy security are specified. The evaluation of the danger is based on how close to the limit values are the indicators positioned.

In its core, the indicative analysis is based on statistic data, relevant to past periods. Nevertheless the collecting of statistic information requires a considerable amount of time. In different countries different indicators are used, which limits the comparability of the results.

Risk evaluation in energy security

The increasing of uncertainty and the necessity of its calculation defines the broadening of methods for evaluation of energy security. One of the solutions is the usage of the theory for risk analysis and management.

In USA, the Index of U.S. Energy Security Risk is used, developed in 2010 by the Institute for 21st Century Energy to the US Chamber of Commerce. [5] In 2012 the International Index of Energy Security Risk is developed.[6]

A perspective methodology for evaluation of the energy security, combining the quantity and quality approaches, is the methodology, based on metric solutions for risk evaluation. Applied to the energy system, it includes the following stages.

(1) Risk identification

On this stage an expert evaluation is mainly used. Analysis of the situation is performed; the problematic areas in the energy system are being detected. On the basis of general knowledge of the risks, the specific risks for the energy security in the given moment are being determined.

There is a relatively stable understanding for the nature and type of the risks in an energy sector, which in general and as per different criteria, can be classified as:

- External and internal;
- Manufacturing, financial, commercial;
- Environmental, technical/technological, political and economical;
- Ecological, social;
- Persistent, periodical, one-time, etc.

(2) Risk analysis

The risk is considered as a function of the consequences (size of damage/harm) and probability of their occurrence. So, in accordance with Standard AS/NZS 4360:2004 [7]:

$$\text{Risk} = \text{Consequence} \times \text{Likelihood} \quad (R = C \times L)$$

A matrix approach is being used, in which a risk map is prepared.[8] One of the significant methodological problems with this approach is the selection of the size of the matrix. Three-stage (3X3) or five-stage (5X5) scales for two-dimensional matrix are used. In our opinion, the 5-stage scale allows a more detailed evaluation of the risk.

A specific meaning is set for each of the components, as follows:

Probability for occurrence of risk event:

1. Very low
2. Low
3. Medium
4. High

5. Very high

Value of damages/losses:

1. Minimal
2. Low
3. Medium
4. High
5. Maximum

A two-dimensional matrix is built, in which the values for probability of occurrence of risk events and values of potential losses/damages are combined. The relevant meanings are determined for each identified risk, as expert evaluation is used. As a result, the index for each risk is being determined.

Tab. 1. Risk map

L						
5	5	10	15	20	25	
4	4	8	12	16	20	
3	3	6	9	12	15	
2	2	4	6	8	10	
1	1	2	3	4	5	
	1	2	3	4		CC

(3) Risk evaluation

The evaluation is performed on the basis of the calculated indexes for each risk. In this operation we use pre-prepared criteria for the risk influence on the energy system and socio-economic relations and risk level from the standpoint of relations/reaction of the subject (of energy security) to it.

Tab. 2. Stages of risk influence

Stage of influence	Interval
1. Negligible	1–4
2. Insignificant	5–9
3. Mediocre	10–14
4. Considerable	15–19
5. Critical	20–25

Tab. 3. Risk level

Risk level	Interval
1. Acceptable	1–9
2. Justified	10–19
3. Unacceptable	20–25

The disclosure of the level of influence of each of the risks allows the evaluation of possible losses/damages in practice. The knowledge of the risk level and permissible (acceptable) limits contributes for determination of necessity of differential influence on the risks for the purpose of decreasing the negative outcome on the energy sector and socio-economic relations.

(4) Reaction to risk

On this stage strategies are being determined – preventive or influencing, as well as relevant methods for handling the energy risks depending on their dimensions.

The handling of risks is an activity, continuing in time. It suggests not only a "snap shot" but tracking processes in security area and specifically in the energy sector, through observation and analysis of changes.

Conclusion

The application of the risk theory gives the opportunity for obtaining a more detailed idea for the situation in the energy sector, mainly in the aspect of limiting of the negative processes in its function. The disclosure of uncertainties through identification, analysis and evaluation of risk dynamics is a prerequisite for a review of the energy policy and strategic activities for guaranteeing energy security.

In methodological aspect, this approach gives the opportunity for combining quantity and quality methods for analysis and evaluation. It is mainly based on evaluations of experts, which interpret the quantity parameters in the coordinate system of the security and realization of public and personal interests.

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