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The energy policy risk management system model: theories and practices

ABSTRACT: The article aims to study the determinants of the energy policy implementation process from risks and danger perspectives by building the risk management system model. The research methodology is based on the application of the risk map to the energy policy. Our results confirmed that the risk map could be applied in the energy industry to identify the risks and to implement the energy policy risk management system model which will prevent critical uncertainties and risk structure, identified from the risk map as well as bring the energy industry to the future state by implementing scenarios and strategies, developed by the World Energy Council. The research limitations are that the main limits are concerned with the lack of the evaluation results of the energy policy risks aimed for the system management of the changes which these risks may introduce. No empirical study has been conducted. The application of the risk map is related in a major part to the enterprise level with financial and technical purposes of changes. In the research we made an

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attempt to develop the managerial recommendations for the regulators on how to make a transitions of risks to opportunities of introducing and managing changes in the framework of the energy policy risk management system model. The originality/ value of the paper consists firstly, in the innovativeness of applying the tool of matrix forecasting to the energy sector; secondly, in providing a supporting tool to policy-makers and managers decisions.

KEYWORDS: risk, energy policy, risk management, system model

Introduction and Literature Review

Looking to the historical retrospective and enthusiasm in the 1970 of the policymakers we may fix the active introduction of different innovations and green jobs. The European Parliament provides a range of rationale to promote renewable energy support (Capros and Samouilidis 1988). There are several studies, based on the comparison of the energy policy costs effectiveness (p. 8) in which quantitative policy indicators were introduced. The research lead to the conclusion that the higher remuneration level more than USD 0.07 per kilowatt hour (KWh) do not correlate with the greater policy effectiveness in an obligatory manner. The explanation can be found in the existing non-economic barriers and investors relation to risk, as well the conclusion of the efficiency to combine state subsidies with the support of the research and development for renewable sources with the discount price strategies for the customers. They develop a unifying theoretical framework according to which the price policy should consider the following determinants they suggested to develop an overlapping policy to combine the common practice of using these sources for environmental purposes. The authors came t a conclusion, that proper policy evaluation should not be put in a narrow context.

Going to the forecasting of the energy policy scenarios in 2007 by the World Energy Council (WEC 2007), we can see the emphasis on the necessity of engaging honest citizens to the new market design discussion and on the possibility of the solution of macro risks in investors' encouragement and regional integration of pipelines. The Council separated four scenarios, including: Leopard, Elephant, Lion and Giraffe for which economic activity (GDP), energy intensity, total primary energy requirement (TPER), greenhouse gas emission and emission intensity were studied.

The scenarios developed in 2019 included so-called (WEC 2019): Modern Jazz – “digitally disruptive innovative privatized world”; Unfinished symphony – world with sustainable economic growth, based on renewable energy future; Hard Rock – environment with priorities of national security, which is not considered as a source of sustainability. For these “musical” scenarios the content and comparative introduction were suggested as well. The results showed that for the Hard Rock situation the social needs, business-models and technologies are subordinated to the regulation. The regulation itself drives the changes through the protectionism, local taxation, substitutes, monitoring balance between business solvency and local

wealth. Influencing the business-model is possible by members of the management group from the governmental officials only. The social needs to be met are concentrated in convenience and affordability.

Timothy Wirth (Wirth 2003) also saw the perspective of the digital revolution and results of greater productivity growth, higher economic growth, lower carbon emission and increased national security as public-private partnerships on biotechnology manufacturing. A solution to the problem of global oil dependence and excess carbon dioxide emission was seen in the collaborative approach of manufacturers in the use and provision of reliable energy services.

In World Energy Issue Monitor 2020 (WEC 2020) the researchers outline the global perspectives in critical uncertainty because of the macroeconomic and geopolitical issues, mainly in the relation of China as main energy investors and the USA as a leading energy exporter. The results of the main world critical uncertainty is presented on Figure 1.

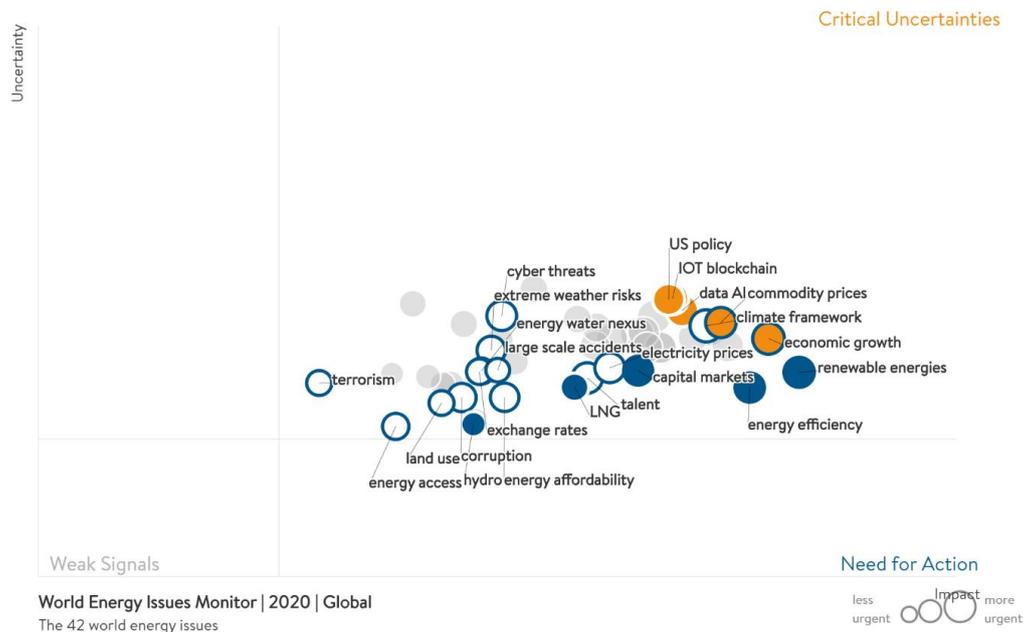


Fig. 1. Critical uncertainties for energy industry
 Sources: own study based on (WEC 2020)

Rys. 1. Krytyczne niepewności dla energetyki

According to (Dyduch et al. 2020) evolution in the context of the Lisbon Treaty and the Europe 2020 Strategy listed two documents as priorities: the Green Paper and Action Plan for Energy Efficiency. Namely, in the Treaty of Lisbon the legislators put the following among the main goals of the EU energy policy: assurance of the functioning of the energy market; assurance of the secure energy supply in the EU. The Energy Road Map (EC 2012) mentions significant

risks of carbon leakage and investment risks, describes the current advantages of the low risks of investors of gas generation and the possibility to hedge them.

In the Energy Efficiency for Climate Policy study (Jaffe et al. 1999) the authors came to a conclusion of the differences in reaching the goals of technologists' optimum, economists' narrow optimum, theoretical and true social optimum while evaluating energy efficiency and increasing economic efficiency. There is a necessity to consider market signals and environmental externalities to understand the reasons of introducing the policy changes.

In continuation to the description of the Hard-Rock scenario of the World Energy Council the interrelation with the risk of the sovereignty loss is worth mentioning. Chelsea Schelly, Douglas Bessette, Kathleen Brosemer, Valoree and others consider that the current energy policy is very often against it (Schelly et al. 2020). That is the barrier to prioritize community voices in the energy decision-making process for energy system transition, and that the tools, based on energy sovereignty are absent. Based on the main uncertainties, according to WEC and key danger of the energy sovereignty loss, we develop a detailed list of the risks and its sources, influencing the energy policy.

Michael C. Jackson give a deep observation of system methodology by Churchman, Ackoff and Checkland (Jackson 1982). He states that the methodology allows to bring a change to the real world, based on the differences between human activities and hard systems. System models are presented as a social engineering process, that assumes the survival of the system and its adaptation and reforms. The application of the system thinking to the complexity of the system in the retrospective of the last fifty years led to a conclusion of the necessity to base management on the hierarchy of the complexity (Jackson 2009, 2010). Checkland P. presents the overall system thinking methodology for building purposeful activity models by the observers or, in our opinion – stakeholders as well as a process of modelling, formulating a desirable and feasible state and examined it in management science to approve the relevance of appreciative systems theory to modern management (Checkland 2000). The methodology of system thinking to build the energy policy risk management system model will be used in this research.

1. Risk Management approaches in Energy Policy

The scientific and business community continues to discuss and develop proposals for the development of effective tools and methods in strategic and operational management and administration. The value of the enterprise is derived of risk and return. Every management decision increases, protects or reduces the value of the enterprise. Effective achievement of the strategic goals is possible by building a systematic sequence of management of influential risks at all stages of work and in all departments of the organization so that the level of accepted risks was optimal. This approach determines the relevance of risk assessment and management to determine the significance of each individual risk and the total risk load that is associated with the

achievement of the overall objectives of the enterprise. Approaches to risk management for real use in the energy industry should be practical, sustainable and easy to understand.

In the framework of the enterprise risk management (ERM) Deloitte's series on risk management (Deloitte 2013) differentiates such kinds of energy industry risks, as: market/price risks; credit default risks; modelling/ valuation risks; financing/ financial risks; operations risks; strategic/franchise risks; political risks; technological risks; regulatory risks; political risks; legal risks; volumetric risks; business continuity risk; financial reporting risk; environmental risk; staffing organizational risk.

Based on this classification the authors identified risks for energy policy, distributed and numbered by the author on three levels, respectively: Level 1 – risks that are impossible to control; they belong to the elements of the environment in which the energy industry operates. Level 2 – risks that cannot be controlled, but which may be affected by the energy policy. Level 3 – internal risks that can be managed by the energy providers. A description of the sources and risk factors is given in Table 1.

TABLE 1. Sources of risks and classification of energy policy risks

TABELA 1. Źródła ryzyk i klasyfikacja ryzyk w polityce energetycznej

Type of risk	Source/risk factor
1	2
Level risks 1	
1.1. Political risks	Unpredictable government actions, political instability
1.2. Macrosocial risks	Military actions, civil riots, riots and protests, actions of international and non-governmental (public) organizations, protests of the population
1.3. Risk of privatization/ nationalization or confiscation of property	High level of corruption and excessive bureaucracy of public authorities
1.4. Macroeconomic risks	Economic instability, economic downturn, declining GDP, purchasing power, inflation, embargoes, restrictions on imports or exports
1.5. Macrofinancial risks	Financial instability, change in the direction of international capital flows, the complexity of hedging instruments, reduction of budget funding
1.6. Force majeure risks	Natural phenomena, earthquakes, storms, floods, fires, civil unrest, hostilities
1.7. Environmental risks and risks of man-made disasters	Natural disasters, high population density and a large number of industrial enterprises in cities, high depreciation of infrastructure
1.8. Risks of seasonality	Deterioration of weather conditions, fluctuations in demand
1.9. Specific risks	Energy consumption, average per capita production, energy imports, average export/import prices, world energy production
Level risks 2	
2.1. Market risks	Fluctuations in interest rates, fluctuations in prices for goods exported by customers, fluctuations in raw material prices in the activities of leading customers
2.2. Currency risks	Exchange rate fluctuations, changes in the terms of transactions, the introduction of restrictions on foreign exchange transactions

1	2
2.3. Consumer risks	Partnerships, crowding out leading customers, excessive dependence on some large customers, high concentration of business with small production capacity, inadequate understanding of customer priorities
2.4. Risks of competition	Government plans to establish captive ports, development of competing energy providers, arrival of foreign competitors
2.5. Ownership risk, participation risk (in public-private partnership)	Dependence on shareholders and the state
2.6. Pricing risks	State intervention in the formation of prices and tariffs for work performed, services provided
2.7. Legislative risks	Complexity, instability, inaccuracy and ambiguity of legislative norms and changes in them
2.8. Tax risks	Change of tax legislation, tax claims
2.9. Regulatory risks	Changes to licensing requirements, customs control rules and duties
Level risks 3	
3.1. Production and management risks	Overconsumption of raw materials, fuel, energy, increasing the cost of them, increasing production; low discipline of supply, power outages, incompleteness, inaccuracy, untimely information, inefficient organizational management structure
3.2. Commercial risks	Decline and displacement of demand, the introduction of restrictions on the provision of services, adverse changes in market conditions; payment of fines, unforeseen duties and deductions
3.3. Staff risks	Inconsistency of personnel qualifications, difficulties in selecting qualified personnel, operational errors of personnel, criminal actions, problems of delegation of powers and communications, imbalance of powers and responsibilities of personnel; dismissal of top managers, incapacity of key employees
3.4. Technological (operational) risks	Physical and technical condition of equipment, use of outdated technologies, high depreciation of fixed assets
3.5. Investment risks	Wrong choice of investment object, mistakes in the development of feasibility studies, wrong choice of investment partners
3.6. Social risks	Non-fulfillment of social obligations, dismissal of employees and increase of social tensions
3.7. Financial risks: 3.7.1. insolvency	Change in liquidity due to a reduction in current assets, an increase in short- and long-term liabilities, a decrease in receivables from debtors; inconsistency of the debt repayment schedule with the terms of cash formation; the energy provider spends more money than it receives; short-term liabilities grow faster than the ability to receive cash
3.7.2. reduction of financial stability	Decrease in the share of own funds in the amount of liabilities, decrease in the amount of equity and current assets, increase in long-term and short-term liabilities
3.7.2 increasing break-even level	Decrease in revenue, increase in variable and fixed costs
3.7.3. efficiency decline (turnover)	Change in revenue and asset value, increase in receivables and payables, production and sales costs, increase in inventories
3.7.4. reducing profitability	Decrease in average industry profitability, change in net and operating profit, revenue, asset value and equity

1	2
3.7.5. inadequate valuation of assets and their impairment	Changing price conditions
3.7.6. inadequate costing and excess operating costs	Errors in calculations and methodology of calculations, rising prices
3.8. Credit risks	Unfairness and insolvency of counterparties, credit institutions
3.9. Energy sovereignty loss risk	Impossibility to provide energy independence

Source: own study.

According to the list of the risks the risk map may be built based on the scale of the energy policy. Depending on the purpose of the risk evaluation we may introduce global, national, regional or enterprise level grades for risk assessment. Namely for the evaluation of possible losses the five categories in relation to the gross income may be applied, see Table 2.

TABLE 2. Scale of energy policy for risk map building

TABELA 2. Skala polityki energetycznej dla budowania mapy ryzyka

Impact category	Description of the category of consequences	Size of possible consequences – share of energy consuming costs [%]
Category 1	insignificant	1–5
Category 2	permissible	5–9
Category 3	sensitive	10–29
Category 4	critical	30–49
Category 5	catastrophic	More than 50

Source: own study.

By using the scale of possible losses, i.e. risk consequences and risk probability scale we can build the map for the certain level of energy policy implementation (see Fig. 2).

In order to build the system model of risk management in the energy industry let us consider the key inputs, element and influential forces in it.

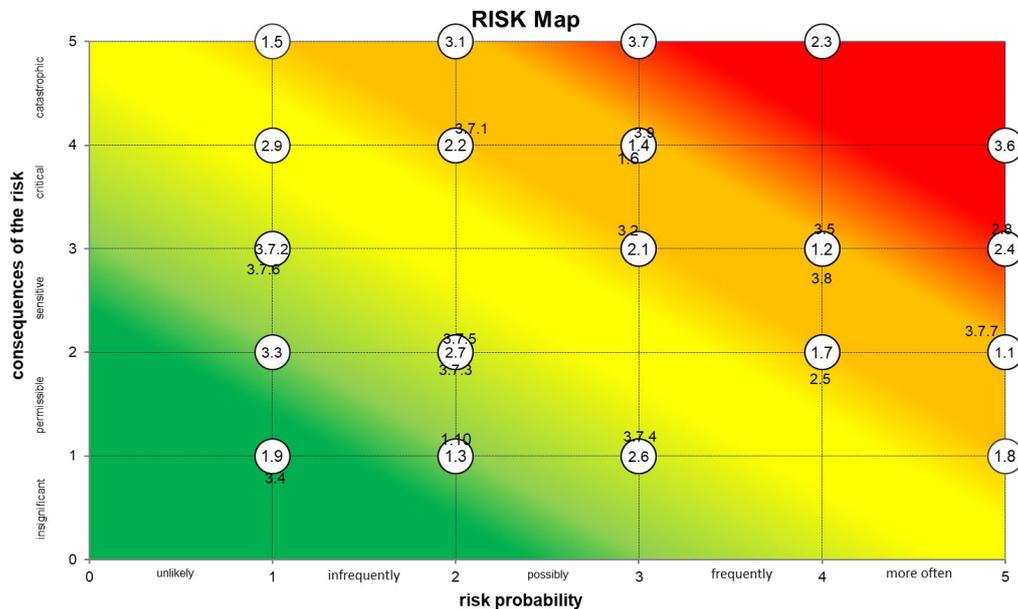


Fig. 2. Risk map: case of universal visualization for enterprise, regional, national or global level

Rys. 2. Mapa ryzyka: generalny sposób wizualizacji na poziomie przedsiębiorstwa, regionalnym, krajowym lub globalnym

2. Implemented system risk management solution for energy policy

In order to implement the scenarios of decarbonization and energy sovereignty we may identify the following driving forces: 1. Regulators, 2. Scientists, 3. World economic council. Restraining forces: 4. Persons, who consider the problem of renewable energy production placement; 5. Owners of oil, coal and gas resources; 6. Manufacturers (Fig. 3).

The component and, one can say, the basic aspect of safety is the involvement of all employees in the organization in monitoring the work environment and the early detection of threats. It is understood that every employee is responsible for risk management in the area of his/her competences, in particular to prevent threats in the scope of performed tasks, as well as reporting any events. Selected key risks that may be exposed during mining operations are presented below. Global economic and environmental changes are increasing the risk burden in the energy industry. The principles of risk prevention in the energy policy are to increase the ability to cope with extreme conditions by raising awareness and showing sensitivity to them.

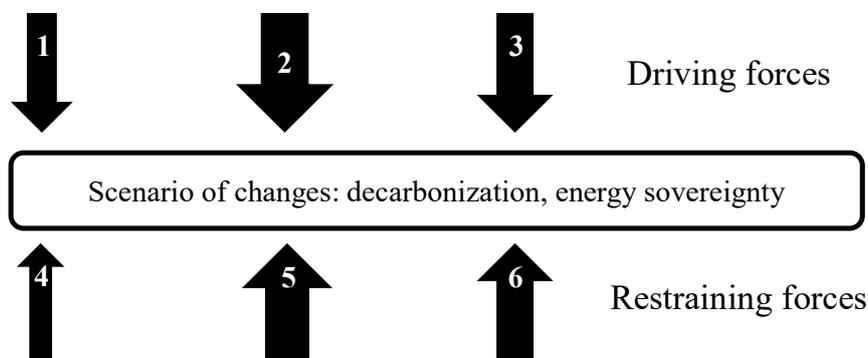


Fig. 3. Scheme of the field of power in the energy industry
 Sources: own study

Rys. 3. Schemat czynników sprawczych w energetyce

The implementation of energy policy risks affects the sustainability of the industry. Among the various types of energy sources, it is the policy itself that provide norms and rules, which contributes to the industry's development. It is therefore important to consider the risks of the energy policy in terms of vulnerabilities. Despite the variety of approaches to risk classification, their main drawback is that they do not provide a comprehensive picture of the existing risks of the energy policy. In addition, there is no clear correspondence between the factors of origin and the management methods. In the classification approach proposed for the risk map, the risks are distributed both by certain types and meet specific criteria for monitoring the risk load. In addition, the classification approach used to construct the risk map was formed precisely in order to prevent the realization of the total risk of energy sovereignty loss. Risk maps can help industry leaders assess vulnerabilities and develop appropriate strategies to minimize risks. The assessment and monitoring of the energy policy risk load can be performed using a graph-analytical tool – a risk map, used widely as well by the World Energy Council. It allows you to clearly depict the impact of each risk on the activities of the energy providers in the coordinates “probability of occurrence – potential damage”. The risks shown on the map form their profile. Each of them is presented in terms of probability (%) and the amount of potential loss in monetary terms in the relevant categories. When constructing the map, it is necessary to enter the initial data of the expert assessment (experts: governors, deputy directors, engineers, risk managers) according to the criteria “probability of occurrence – potential damage”. An example is the risk map as a tool for monitoring security management. The expected knowledge of experts and assessments of possible situations are described and presented in the form of details on one graph and require certain explanations.

The hypothetical situation related to certain input information, which covers the characteristics of the energy policy risks, is illustrated in a simplified way. In hierarchical systems, the whole decision-making process may include several levels of decision-making of interacting experts.

The risk map is a risk analysis tool for consolidating results that can be used to increase the certainty of the environment for management decisions. Managers have the opportunity to determine whether the level of probability and loss inherent in each risk is acceptable. This is especially important in the sense that, depending on the level of risk, methods of managing it are identified. Therefore, the main purpose of using a risk map is not to quantify the probability and consequences of adverse events, but to determine whether the actual level is acceptable. It should be noted that the consolidated approach is characterized by the variability of rating scales. Risk assessment criteria should also be reviewed in the context of the prospects for management decisions and the receipt of new information on the origin and origin of risks. Thus, the risk map is a matrix in which the results of the risk assessment are consolidated.

In any case, the purpose of using a risk map is to choose a rational method of risk management. In the selection process, it is recommended to take into account the fact that risk management methods, established in accordance with individual risks, generate the consequences of increased costs for their implementation. If it is necessary to reduce the costs of risk management, it is advisable to group risks and form a portfolio of methods of influencing them by groups. Thus, policy risk management will be comprehensive not only based on the risk map. On Figure 4 we present the management output-input scheme for building system model, which includes the data of risk mapping.

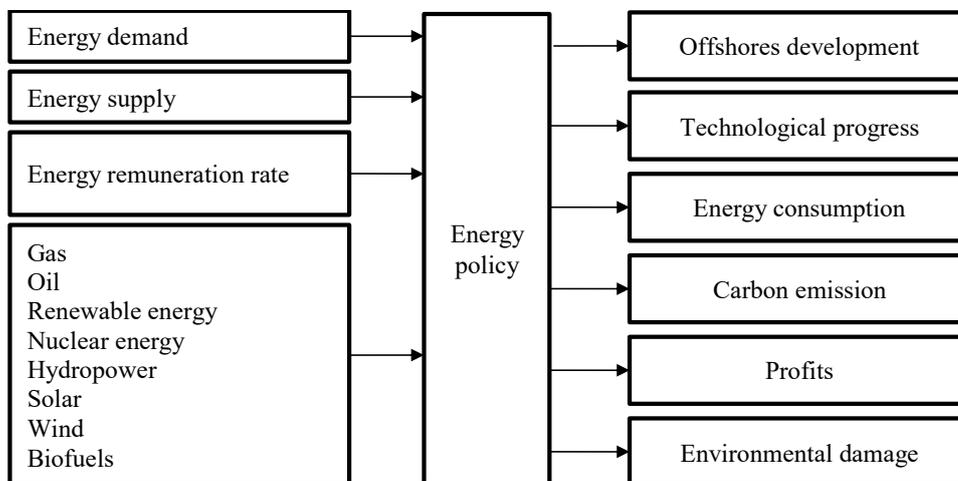


Fig. 4. Scheme input-output in the energy industry
 Source: own study

Rys. 4. Schemat wejść i wyjść w energetyce

Further step to see the main stakeholders of the energy policy is to identify the influential participants, among them are (Fig. 5):

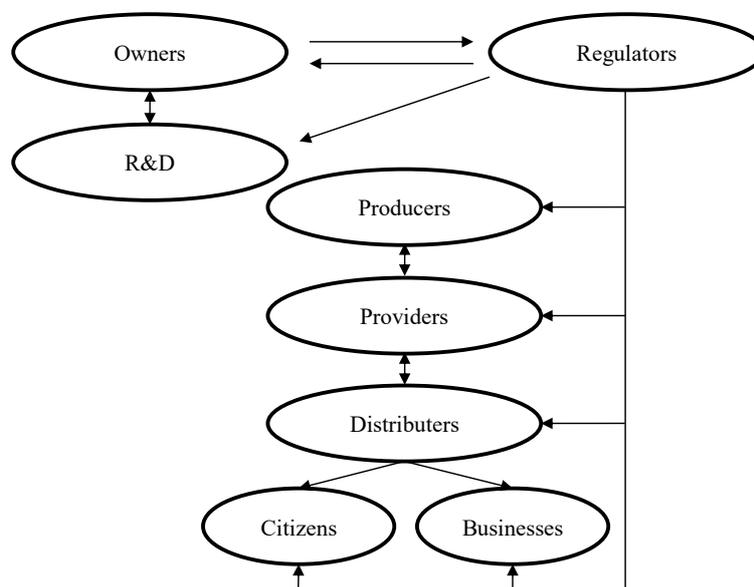


Fig. 5. Scheme of influence in the energy policy
 Source: own study

Rys. 5. Schemat oddziaływania w polityce energetycznej

To monitor the risk load, a special format for using this tool for decision-making in risk management systems in general has been proposed. Peer reviewers are always at risk of underestimating or overestimating certain facts, measurements, feelings and values, especially when some information elements are vaguely presented and when all these threats are closely inter-related and affect each other. Decision-making is much more difficult in cases where the situation changes over time and when the decision must meet certain requirements not only at the moment, but also in the medium and long term. Many vaguely described situations arise when considering energy operators security. The full range of problems in this area can be assessed by analyzing relevant documents and comprehensive materials prepared by government agencies and industry subjects.

It is well known that a decision is usually formed on the basis of some verbal qualitative characteristics (after their normalization) and quantitative parameters obtained from the environment, action plan or situation during the investigation or from other sources of information. Therefore, in information systems that support security, there are many decision-making points in the whole chain of activity. On the other hand, modern experience allows to expand the concept of using risk maps, including additional vague expertise and a consideration of real situations. In order to identify all these decision-making points for risk management we should build the energy policy system map (Fig. 6).

The decision-making process required the risk load to be optimized. The assessment of risks is usually based on the results of assessment of the identified risk. Risk assessment consists of

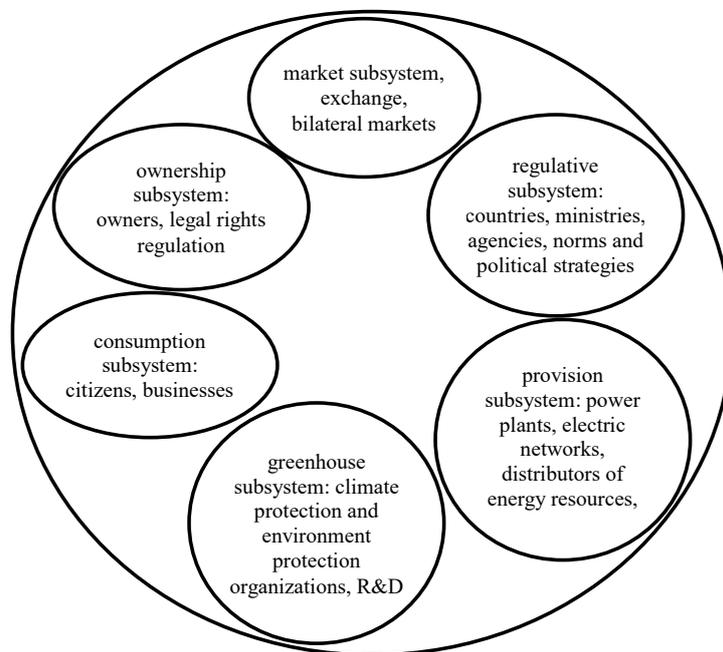


Fig. 6. Energy policy system map

Source: own study

Rys. 6. Mapa systemu polityki energetycznej

two independent components: the probability of risk and potential loss. Taking the probability of realization of risks and the amount of potential damage into account provides an opportunity to explore the qualitative aspects of the risk burden of the energy industry in order to apply a specific list of risk management methods. Once the possible probability and loss are assessed for each identified location in the matrix, the risk impact can be calculated as the multiplied risk probabilities on its potential impact. Based on the risk, a list of governmental priorities is formed, according to which you can decide how to respond to it, as well as provide and allocate resources for response. Mrozowska A. (Mrozowska 2019) used the risk map for assessing the sea area regarding the offshore industry of gas and oil.

When conducting expert assessments, the following requirements must be complied with: completeness, reliability and the completeness of information on the results of a particular energy provider within the integrated risk management system; identity of periods analyzed by experts; uniformity of terms of expert assessment; availability of professional competence and experience in the energy industry; objectivity; lack of personal interest in the evaluation results; no consequences for experts depending on the results of the assessment. Expert probability estimates are applied according to the categories of consequences. Each risk is assigned a risk probability by the expert, with “5” corresponding to the highest probability and the largest amount of consequences. In order to check the consistency of expert assessments for the selected scenarios,

the arithmetic mean is used. The risks are distributed in the cells of the map in accordance with the expected loss from the implementation and the probability of occurrence of each of them. The map is divided into several zones in such a way that the risks indicated in one of them are equally dangerous for the industry. Propensity to risk is classified into three zones: 1) in which the risk is acceptable; 2) in which it is desirable to use risk management methods; 3) in which risk management is a necessity.

A risk analysis is performed to assist decision makers in understanding vulnerable systems. Thus, the governors adopt appropriate strategies to prevent and reduce the risks of the energy industry. The public sector needs to formulate strategies for energy provider vulnerabilities (i.e. high and extreme vulnerabilities) based on long-term considerations. In order to optimize the level of risk, public regulators should develop integrated regional planning to reduce infrastructure vulnerabilities and the impacts on the society, as well as to provide robust early warning systems to prevent cumulative risks and improve self-defense capabilities of the national economies. One of the key aspects in the context of the use of the risk map is the impact on management decisions on energy policy development.

The concept of effective decision-making is used to determine the outcome, when the decision-making process is aimed at creating the future, rather than trying to achieve a specific scenario. Effective justification takes the cost budget into account, considering the future as unpredictable, and focuses on a set of tools to achieve efficiency. This version of logic is characterized by experiments and flexibility. In general, the implementation of this logical approach can be described as focused on discovery, novelty with the basic assumption: "if we can control the future, we do not need to anticipate it." The expected efficiency will promote innovation in conditions of high uncertainty (see Fig. 7).

The risk structure of the energy policy is presented at the following levels: the level of its elements; the level of their interaction; level of interaction with stakeholders of the industry. Better detail of the risks helps to determine its promising design and ability to generate a shared value for stakeholders. The structural analysis of the risks, the relationship between them and the relationship of stakeholders allows to determine the priorities of the energy policy transformation and a critical path to the planned development outcome by optimizing the impact of risks.

Thus, the risk management system model has been identified as an additional field for implementing tools in the field of energy policy. The presented criteria and assessment methods can be applied to risk management of the energy industry in order to identify and assess promising ways of its development. Strategic forecasting can help reduce the number of observations by eliminating inaccurate assumptions about expected revenues with reliable scenarios. This helps to increase the reliability of risk load calculations and the choice of risk management methods, which thus increases transparency about the possible results of decision-making by those responsible.

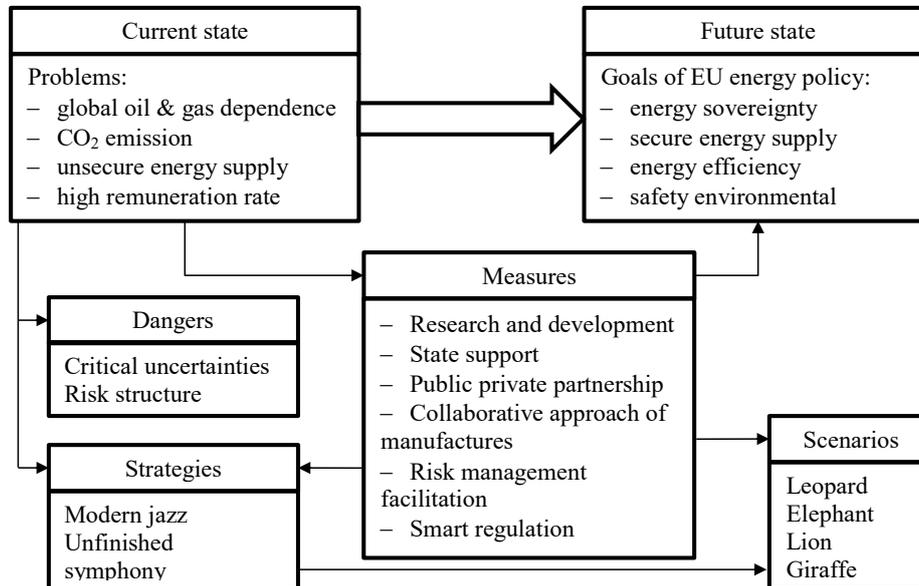


Fig. 7. System model of the energy policy risk management
 Source: own study

Rys. 7. Model systemu zarządzania ryzykiem w polityce energetycznej

Conclusions and discussion

The presented analysis allowed us to build the risk management system model, which we create by using the following logical scheme:

1. Development of the input-output scheme of energy policy.
2. Building the scheme of influence, to fix the supportive and disruptive forces to implement the scenario of decarbonization and energy sovereignty.
3. Creation of the system map, consists of subsystems and its elements, such as: ownership, market, regulative, consumption, greenhouse.
4. Finalize the system model, which allows for certain measures of the energy policy to reach the future state of the industry without the current listed problems to be implemented.

The future perspectives of this research can be seen in the expansion of the system model to the decision-making process of the regulators, based on the stakeholders visions of the energy industry to make the process more transparent, problem-solving and effective in comparison to the Energy road-map 2050.

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Model systemu zarządzania ryzykiem w polityce energetycznej: teorie i praktyka

Streszczenie

Artykuł ma na celu zbadanie uwarunkowań procesu realizacji polityki energetycznej z perspektywy ryzyk i zagrożeń dzięki zbudowaniu modelu systemu zarządzania ryzykiem. Metodologia badań opiera się na zastosowaniu mapy ryzyka dla polityki energetycznej. Uzyskane wyniki potwierdziły, że mapa ryzyk może być zastosowana w energetyce do identyfikacji ryzyk i wdrożenia modelu systemu zarządzania ryzykiem w polityce energetycznej, który zapobiegnie krytycznym niepewnościom i ryzykom strukturalnym, zidentyfikowanym na podstawie mapy ryzyk, a także doprowadzi przemysł energetyczny do zaplanowanego stanu wynikającego z wdrażania scenariuszy i strategii opracowanych przez Światową Radę Energetyczną.

Ograniczenia badawcze wynikają głównie z braku możliwości oszacowania ryzyka wdrożenia polityki energetycznej poprzez systemowe zarządzanie zmianami i ryzyka, jakie te zmiany mogą spowodować.

Nie przeprowadzono żadnych badań empirycznych. Rodzaj zastosowanej mapy ryzyka zależy głównie od przedsiębiorstwa oraz od finansowych i technicznych celów przeprowadzanych zmian. Podjęto próbę wypracowania rekomendacji zarządczych dla regulatorów, na temat tego, jak dokonać zamiany ryzyk na szanse i umożliwić wprowadzenie zmian i zarządzania nimi w ramach modelu systemu zarządzania ryzykiem polityki energetycznej. Oryginalność artykułu polega przede wszystkim na innowacyjności zastosowania w energetyce narzędzia prognozowania macierzowego, jak również na zaproponowaniu narzędzia wspierającego rozstrzygnięcia decydentów i menedżerów.

SŁOWA KLUCZOWE: ryzyko, polityka energetyczna, zarządzanie ryzykiem, model systemu