Article

Risk Factors in a Logistics Company Using Renewable Energy Sources

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Abstract: Investment in renewable energy sources by logistics companies has become commonplace. Organizations decide to invest in renewable energy sources not only for economic or environmental reasons, but because it is also prestigious for them. The aim of this article is to present the possible risk factors for a logistics company that uses or wants to implement renewable energy sources. This study identified individual risk factors and control mechanisms to reduce the likelihood of a particular risk factor occurring. In this article, the research methodology used is risk management through implementing a diagram of the risk-related decision-making processes of logistics companies around renewable energy sources. The analysis of the risk factors of renewable energy sources is an important element in assessing their effectiveness. By implementing the procedure of selecting an appropriate renewable energy source by logistic entities and implementing an element of risk management, there will be a significant positive impact on the optimal selection of a renewable energy source by enterprises.

Keywords: renewable energy sources; enterprises; economic assessment; investments

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1. Introduction

Humans are the main elements shaping their surroundings, including the environment. Humans are often willing to use available resources, which, although unknowingly, destructively affects nature. Over the years, the level of negative environmental impact had by humans has become significant. It has become necessary to look for an alternative to non-renewable resources. In this context, the economic and ecological zone has turned into a contradiction [1,2], and, at the moment, the sustainable development of both areas is being pursued. Minimizing the negative impact on the natural environment by logistics companies is as important an element for organizations as constant development. Investing in renewable energy sources is a long-term process. Therefore, the selection of a renewable energy source is of fundamental importance in order to maximize the potential of renewable energy. The negative effects of climate change continue to worsen. There is an increase in temperatures, as well as the severity and frequency of natural disasters [3]. This element not only affects ecology, but also causes economic losses. Therefore, there is a need to manage risk in terms of ecology and economy, including logistics [4,5].

At present, the main problem is the systematic decline of the number of non-renewable resources and the pollution of the natural environment. Modern technologies' transforming energies degrade the natural environment, where the energy generated from coal and oil has the most negative impact. Due to the subsequent irreversible climate change, an alternative element is sustainable development, where renewable energy sources are used [6,7]. Logistics companies decide to invest in renewable energy sources not only for economic or environmental reasons, but also because it is prestigious for the organization. Choosing the most effective source of renewable energy for a given entity is a key element.

The aim of this article is to present risk factors for a logistics company using renewable energy sources. The research identified individual risk factors in the following types of re-

newable energy: solar, biomass, and wind energy. Methods of counteracting the occurrence of a given risk factor in a logistics company, while protecting the natural environment, were indicated. In the article, the research methodology used is risk management through implementing a diagram of the risk-related decision-making processes of logistics companies around renewable energy sources. The decision to select a given type of renewable energy source requires the detailed identification and analysis of possible risk factors. Proper risk management should start at the stage of investment in an unconventional energy source and then be cyclically carried out during the use of a given energy source. Investments by logistics entities in renewable energy sources are initially high financial investments but should, after some time, bring financial benefits to the entities. The most important element, however, is to maintain the continuity of logistics activities performed by a given entity, where the key element is to prevent the lack of access to energy. Implementing the procedure of selecting an appropriate source of renewable energy, with the simultaneous management of risk factors, significantly influences the coordination of the effective and pro-ecological development of the company.

2. Renewable Energy Sources

The development of renewable energy sources (RES) is one of the fastest growing sectors of the economy in the world market. The intensity of the development of unconventional energy sources stimulates transport, construction, energy production, and storage [8,9].

Energy from renewable sources include water energy, solar radiation, wind, and earth energy, which includes biomass and geothermal energy. Investments in renewable energy sources by enterprises and natural persons result in measurable environmental, energy, and financial effects. The constant increase in the number of available renewable energies has had a measurable effect in reducing energy resources, improving the condition of the natural environment and organic emissions of pollutants into the atmosphere and waters, and reducing the amount of generated waste, the disposal of which is impossible [10,11].

Environmental investments in the RES market have both positive and negative features. Elements conducive to development in renewable energy sources include [8,12]:

- steadily rising commercial energy prices,
- free availability of products for obtaining renewable energy,
- functionality of solutions,
- availability of sources of financing from the state and private budgets, and
- environmental awareness in society.

The main elements reducing investment in renewable energy sources are [8]:

- a lack of financial support for investors,
- high prices of products necessary to obtain electricity,
- a lack of legal and financial facilitations, and
- a long payback period.

Each country has a certain specific RES potential that cannot be compared. Each state and economic entity has limited possibilities in terms of selecting an appropriate source of renewable energy. These are the criteria [13,14]:

- technical aspects,
- economic,
- market,
- latitude,
- access to the sea/ocean,
- number of watercourses, and
- the share of agricultural crops and forests in the total area.

Logistics companies most often invest in the following renewable energy sources: solar energy, biomass energy, water energy, and wind energy. Table 1 characterizes the basic sources of renewable energy. The type of investment and operation are also specified.

Table 1. Characteristics of renewable energy sources.

Type of Renewable Energy	Characteristic
Solar energy	Solar energy can be transformed into electricity and heat. It is used in heat engineering (thermal solar collectors) and power engineering (photovoltaic cells). Solar collectors convert solar radiation into thermal energy. Photovoltaic cells are used in the direct conversion of solar radiation to electricity. A photovoltaic cell converts solar radiation directly into electricity. It does not adversely affect the environment as there is no by-product of pollution and noise. It shows the least negative impact on the environment.
	Characteristics of investment and operation
	Problem with storing and using the produced energy at the right time.
	High cost of enabling devices for conversions.
	Installing solar panels mainly on roofs. It is possible to mount them on the walls, southern buildings or the ground.
Biomass energy	Characteristic
	Biomass is the oldest renewable energy source. These are organic plant products, e.g., wood and plant waste (straw and municipal waste). The term ‘biomass’ also includes refined wood fuel. It is mainly wood briquettes and pallets.
	Characteristics of investment and operation
	The energy contained in biomass can be processed into other, very convenient forms of biofuels.
	Plant biomass obtained during changing weather conditions usually has increased humidity and requires additional drying. The drying process of biomass is carried out before its storage in order to eliminate the water contained in the material.
Water energy	A commonly used method of mechanical processing of biomass is its comminution (cutting, chipping) and pressing, briquetting, or pelleting.
	Characteristic
	Mechanical energy flowing from water is used in renewable energy sources and, more precisely, in water energy. Energy conversion is used to obtain electricity (hydropower) or to drive machines, i.e., for turbines or water wheels.
	The energy of water is broken down into different energies:
	<ul style="list-style-type: none"> – river flow (kinetic energy is converted into electricity), – the mechanical energy of the oceans (movements of water mass caused by tides, waves, or differences in density).
	Characteristics of investment and operation
	The energy of this method is only used near water. Limited localization of water energy use.
Wind energy	Very high investment and operating costs. The highest source of renewable energy mentioned in this work.
	The amount of potential energy depends on the height of the water drop. Fluctuations in the intensity of energy produced
	Characteristic
	The energy of wind and electricity production is generated in modern wind farms. It enables obtaining energetically useful energy. The principle of operation is the conversion of the kinetic energy of the wind into mechanical energy, which is then converted into electricity.
	Characteristics of the investment and operation
Wind energy	The wind used is an everyday phenomenon, this one a kind of “natural resource” will never be exhausted.
	The investment is very expensive. The costs of its installation are reimbursed depending on the power of the plant, after 5 to 25 years.
	The windmills generate noise. They also force the installation of power plants away from buildings.

Source: [15–21].

The document of national law regulating issues in the energy sector is the “Energy Law”. The Act specifies [22]:

- principles of shaping the state’s energy policy,
- rules and conditions for the supply and use of fuels and energy, and
- principles of operation of energy enterprises and authorities competent in matters of fuel and energy management.

3. The Risk of Green Logistics Companies

More and more entrepreneurs are investing in renewable energy sources, becoming so-called green jobs. By giving up or limiting the acquisition of electricity in a conventional manner. The implementation of the sustainable development of enterprises concerns processes related to the production, use, and recycling of devices using renewable energy sources [8].

Preserving the natural environment should be a priority for logistics companies, while at the same time the continue to develop the organization. It requires meeting appropriate standards and environmental obligations, including the use of renewable energy sources and creating clean production technologies [10].

The constantly decreasing number of natural resources makes entrepreneurs realize that investing in renewable energy sources must be a long-term process. Therefore, the activities performed are aimed at the further development of the organization without increased consumption of natural resources.

The concept of sustainable development requires enterprises to implement the concept of corporate social responsibility in an attempt to increase their competitive advantage by [8,23]:

- broadening social competences,
- having a higher innovation index,
- improving the environment in which the organization operates, and
- identification of potential risk areas and selection of the priority sphere.

The concept of risk can be defined as the possibility of an event that will affect the achievement of the organization’s goals. It has a measurable effect and probability. Enterprises perceive risk factors as a negative element [24]. The knowledge of the possible occurrence of risk factors constitutes the basis for commencing actions aimed at counteracting the occurrence of the negative effects of disturbances.

Risk management should be deliberate and planned. Therefore, a key element is the development by the entity of control mechanisms aimed at counteracting the occurrence of disturbances. It is also important to take a comprehensive look at the organization and the prevention of risk factors not only in a given process, but in all processes occurring in the organization.

Risk management is compliance with the formula of the entity’s management effectiveness, extended by the management stage. The aim of risk management is to optimize the benefits resulting from the reduction of risk factors and the reduction of possible losses. In order to effectively manage risk, it is necessary to know the sources of risk factors and what disruptions affect their occurrence [24].

There are four main groups of risk factors that affect companies’ investing in renewable energy [25,26], they are:

- political and legal risk,
- technical risk,
- economic risk, and
- social risk.

Making the decision to invest in renewable energy sources requires risk factor analysis to be conducted. Proper risk management, leading to the achievement of the assumed goals, should start at the stage of planning a given investment and using devices for obtaining renewable energy [25].

4. Risk Factors Using Renewable Energy Sources in the Enterprise

After characterizing renewable energy sources that can be used in logistics facilities, the three most commonly used renewable energy sources were analyzed for further research:

- Solar energy,
- Biomass energy,
- Wind energy.

In terms of logistics companies, the following were distinguished: transport, production, and warehouse companies. A characteristic feature of these organizations is high energy demand, and they play a key role in the supply chain. Therefore, the analysis of renewable energy sources is based on the key links of the supply chain.

Risk factors were distinguished, characterizing a specific source of renewable energy by assigning it to a given type of logistics company. A group of risk factors that can occur in any logistics company has also been defined. Table 2 shows the risk factors that may occur in logistics companies that invest in and use renewable energy sources.

Table 2. Risk factors of a logistics company using renewable energy sources.

Type of Renewable Energy	Type of Logistics Company	Risk Factors	Control Mechanism
Solar energy	Transport company—electric energy of vehicles	Incorrect display of information about the battery percentage in the vehicle.	Data standardization for vehicle users, suppliers, and consumers.
		Uncontrolled breakdown of the battery.	Systematic battery control and repair. Improving the efficiency of battery function.
		Incorrect calculation of the amount of energy needed to transport the goods.	Electric vehicles have the ability to store energy. Intelligent vehicle charging systems. Identification of the vehicle's charging station according to the route to be traveled by the driver.
		Vehicle weight too high. Possibility of overloading the vehicle axle after loading the goods into the trolley.	Elements reducing the weight of the vehicle parts. The use of devices that determine the correct distribution of goods in the trailer.
		The risk of the driver having to change routes. There is not enough energy in the vehicle to complete the journey.	Electric vehicles' access management plans are required to implement access management plans for the electric vehicle charging infrastructure. Creation of a two-way flow of electricity; a "vehicle-grid".
	Manufacturing company	Risk of insufficient solar energy being supplied. Dependence on weather conditions.	Providing consumers with incentives to reduce their energy consumption at peak loads and use them in periods where the amount of energy produced is lower than demand.
	Warehouse company	Uncontrolled temperature changes in refrigerated warehouses. Risk of destroying stored goods. Belts can become deformed and lose their properties after uncontrolled temperature rises and falls.	Conventional energy supply support. Energy storage. Temperature control sensors.
		Incorrect use of applications providing information about delivered energy deposits.	Energy storage. Creation of mobile energy storage for electric vehicles.
	Logistics company	Risk factors that may occur in any logistics company	
		High failure rate of parts. Mechanical parts used in solar panels.	
		Risk of contamination and corrosion of the device.	
		The risk of low efficiency of solar energy use, due to the lack of constant supervision.	
		Risk of high unreliability of some system components.	
		Risk of unstable government policy of financial support.	

Table 2. Cont.

Type of Renewable Energy	Type of Logistics Company	Risk Factors	Type of Renewable Energy
Biomass energy	Manufacturing company	Incorrect determination of fuel consumption during assumed technological operations.	There is a probability of stopping the production line. This also uses conventional energy sources.
		High price volatility of raw material.	The need to raise the price of the manufactured product. Failure to receive the assumed financial return on a commercial transaction.
	Warehouse company	Risk of a limited amount of raw material for drying.	Growing biomass can be seen in many regions as an opportunity for the development of agriculture and can, at the same time, reduce unemployment. Construction of new storage facilities for the storage of goods intended for biomass energy.
Type of Renewable Energy	Type of Logistics Company	Risk Factors	Type of Renewable Energy
Wind energy	Manufacturing company	Limited production capacity.	Supporting the enterprise with a conventional energy source or investing in two different sources of renewable energy.
		Unstable delivery current.	There is a need for reserve capacity. Support of the enterprise with a conventional energy source.
	Warehouse company	Risk of not finding a suitable location for a windmill in close proximity to the facility.	Building a windmill in an undeveloped area. Choosing a different source of renewable energy.
		The risk of too much noise in logistics and residential buildings.	Conducting noise research before starting the investment.
	Logistics company	Risk factors that may occur in any logistics company.	
		Risk of limited installation capacities.	
		Risk of financial investments.	
		Risk of weather influence on the operation and failure rate of the device.	
		Risk of corrosion of the structure.	
		Risk of an unstable government support policy.	

Source: Own study.

The table above shows the risk factors that may occur in logistics companies using renewable energy from solar, biomass, and wind energy. Risk factors have been classified in terms of belonging to a given type of logistics enterprise and appropriate mechanisms that can be used by the entity have been presented. The characterized control mechanisms show monitoring devices available on the market and elements that can be followed by logistics companies making a choice to invest in renewable energy sources and units already using an unconventional energy source.

5. Diagram of the Risk-Related Decision-Making Process around Renewable Energy Sources

Logistics management is a key element during production and distribution. This process consists of planning, organizing, and controlling the flow of energy, product, and raw material from the distributor to the consumer. It is already a very important element at the investment stage [27,28].

One of the goals of logistics is efficiency. This element consists of planning and controlling the flow of raw materials, finished products, and information, while minimizing costs and impact on the natural environment [29].

Over the last few years, there has been a dynamic increase in investments in the field of obtaining energy from renewable sources, which is why it is so important to present risk factors that may occur in a logistics company that invests in and uses an unconventional source of energy.

The selection of any given type of renewable energy source requires the identification and analysis of the probability of the occurrence of risk factors. Proper risk management should be started at the stage of investment in an unconventional energy source and then cyclically repeated during the use of that energy source.

The key element is the development by the logistics company of the diagram of the risk-related decision-making process around renewable energy sources, in order to reduce the likelihood of a risk factor for a particular renewable energy source.

Based on the research carried out in enterprises that are in the process of investing in renewable energy sources or planning such an investment in the near future and the analysis of many cases described in the literature [12,18,29–34] the authors developed a diagram of the decision-making process of logistics companies around renewable energy sources. The starting point was the assessment of their effectiveness in terms of RES risk factors. The authors put forward the thesis that the implementation of the procedure for selecting an appropriate renewable energy source by logistics entities and the implementation of a risk management element has a significant positive impact on the optimal selection of a renewable energy source by an enterprise.

As a result of the research, a diagram of the decision-making process of logistics companies around renewable energy sources was created, presented in Figure 1.

Figure 1. Diagram of the risk-related decision-making process around renewable energy sources. Source: Own study.

The diagram above shows the process of selecting an appropriate renewable energy source while managing risk factors. The block diagram has been divided into five stages:

- (1) Defining the problem—defining the problem of selecting an appropriate renewable energy source with an indication of the availability of a particular energy source.

- (2) Criteria—it is necessary to define possible risk factors during the selection of an appropriate energy source and the use itself. Before making a decision, a logistics company needs to define the goal and the criteria for achieving it.
- (3) Variant selection—implementation of the selected energy source. Analysis and evaluation of the usability of a given energy source.
- (4) Risk factors—developing a risk register as the basic element of risk management, which consists of four elements: identification, measurement, analysis, and control mechanism.
- (5) Effect analysis—final assessment of the energy sources used, consisting of two conditional operations aimed at controlling the consumption and the affectivity of the implemented energy sources. For the possibility of using new or developing already-used renewable energy sources.

Investments by logistics entities in renewable energy sources involve appropriate financial outlays. Although this involves an initially high financial investment, after a certain period of time, it should bring a financial benefit to the entity. However, the most important element is to maintain the continuity of logistics activities performed by a given entity, where the key element is to prevent a lack of access to energy. The procedures developed by logistics entities should be utilitarian. Enterprises should systematically introduce changes to their procedures, taking into account the amount of energy consumed over a period of time.

Risk analysis of renewable energy sources is an important element in assessing their effectiveness. Implementing the procedure of selecting an appropriate renewable energy source by logistics entities, with simultaneous continuous management of risk factors, significantly influences the best decision to invest in renewable energy sources for entities using renewable energy sources.

6. Conclusions

In recent years, there has been a dynamic growth of enterprises using and investing in energy from renewable sources. Increasing competitiveness, additions from the state, environmental protection, the behavior of consumers and potential customers, for whom the pro-ecological behavior of enterprises has an impact on the choice of decisions, mean that this trend will certainly continue.

Making a decision to invest in renewable energy sources requires a detailed analysis of each type of unconventional energy source and the identification and assessment of possible risk factors. This paper indicates control mechanisms which aim to show logistics companies possible actions limiting the probability of the occurrence of any given risk factor.

In this work, a diagram of the risk-related decision-making process around renewable energy sources was developed, the purpose of which is to select the appropriate type of renewable energy source, while managing risk factors. The model is divided into four areas, which indicate the phased implementation and evaluation of the results obtained after the implementation of the renewable energy source. Risk is an inherent element of every logistics company, which is why it is so important to manage it. The identification and analysis of risk factors is a basic element of disruption management, and the developed model for selecting an appropriate renewable energy source will also reduce the likelihood of risk factors.

Risk analysis of renewable energy sources is an important element in assessing their efficiency and provides the opportunity to make the right decision when investing in and using renewable energy source.

The RES risk analysis is an important element in assessing the effectiveness of RES. The procedure developed for enterprises is intended to be utilitarian. Implementing the procedure of selecting an appropriate renewable energy source by logistic entities, with simultaneous continuous management of risk factors, significantly influences the best

decision to invest in renewable energy sources and is also useful for companies already using renewable energy sources.

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