Use of Environmental Management Systems and Renewable Energy Sources in Selected Food Processing Enterprises in Poland

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Abstract: The issue of environmental management systems in food processing companies is gaining importance due to the need to reduce water withdrawal, wastewater, air emissions, and waste generation. New technological solutions and innovations can reduce the negative effects of the enterprises’ production facilities on the environment. In Poland, the phenomenon of increasing use of the amount of renewable energy sources is influenced by, e.g., adopted national and EU legislation, development of new technologies in the field of energy, and increasing awareness of producers and consumers in the field of ecology and environmental protection. It is also important that the state creates favorable conditions for the use of renewable energy in micro-installations. The application goal of the study is to develop a procedure for improvement of the environmental management systems for food processing companies and increase the awareness of potential use and implementation of renewable energy sources by food processing entities. In the theoretical part of the study, methods of comparative, deductive, and synthetic analysis are used. In the practical part of the study survey method, case studies, a simple flashback, and transfer of ideas are presented. The results of the research can be used by state institutions to put emphasis on the implementation of sustainable development of state policy on the food market.

Keywords: environmental management systems; renewable energy sources; food processing sector; Poland

1. Introduction

Sustainable development is often understood as the efficiency of an ecosystem to self-regenerate the main functions of supporting various forms of life [1]. This leads to evolutionary changes in the ecosystem [2,3]. Sustainable development is the integration of social and economic activities, while preserving human rights, natural balance, and sustainability of basic natural and environmental processes [4]. Sustainable development is a process that takes into account four fundamental aspects: economic, environmental, social, and land use (Figure 1) [5].

The greatest and current challenge, on the economic, political, and environmental levels, is the waste generated in the production processes of modern civilizations [6,7]. In December 2015, the European Commission published a Communication to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions entitled “Closing the loop—EU action for the circular economy” [8]. The idea of a circular economy involves closing the life cycle of a product to direct the economy to the tracks of sustainable development. The European Commission also adopted measures to improve the action plan towards a sustainable bio-economy, taking into account the
reduction of production waste [9]. The Commission’s communication contains proposals aimed at increasing innovation in the European economy, creating a market for secondary raw materials, indicating tools for increasing the quality of secondary raw materials, as well as activities in the field of plastics, bioproducts, demolition waste, construction waste, and food waste [10].

![Multidimensional and interdisciplinary aspects of sustainable development](image)

**Figure 1.** Multidimensional and interdisciplinary aspects of sustainable development. Source: [5].

Over the last few years, more and more companies adopted sustainable practices in their business in order to improve their environmental and social responsibility, while maintaining and improving profitability ratios and creating a greater satisfaction and interaction with different stakeholders [11–14]. Obtaining quality and product safety management certificates is a prerequisite for the operation of food enterprises and can be a good start for the implementation of environmental management systems (EMS) (Figure 2) [15,16].

![Stages of environmental management systems](image)

**Figure 2.** Stages of environmental management systems. Source: [16].

Companies that have implemented an environmental management system meet legal requirements for environmental protection, and simultaneously gain economic and ecological benefits. This is because they minimize adverse environmental impacts by reducing pollution [17]. In addition, these organizations strive to improve the environmental
impact of various activities by improving the functioning of the environmental management system, which, in turn, contributes to further alleviation of their environmental impact [18,19].

More and more energy is used in production processes [20]. The dynamic development of national economies results in a significant increase in energy demand [21]. Production processes require increasing amounts of energy. The permanent development of national economies requires increasing amounts of energy. The use of non-renewable energy for heat and electricity generation is about 75%, for fuel production—about 20%. The use of fossil energy for the production of chemicals and other materials is only a few percent [22]. Conventional energy resources, i.e., coal, natural gas, and oil are already insufficient to meet the rapidly growing needs of the global energy industry. The rapid increase in energy intensity of many areas of the economy may lead to the depletion of the above-mentioned resources. Experts alert that, with current energy consumption, non-renewable deposits may run out already in 2040 [23]. Power industry in Poland is based in large part on so-called dirty technologies (energy produced from hard coal and lignite). In connection with the exhaustibility of coal, and in order to fulfill obligations towards CO$_2$ emission in the European Union, the Polish government should intensify actions connected with the development of renewable energy sources (RES) in the country [24–26].

Another important issue is the increasing environmental pollution and climate change caused by conventional energy sources [27]. During energy production, using non-renewable resources, many hazardous substances are released into the atmosphere and waters [28]. Therefore, many organizations, among other economic bodies (such as the European Union), have begun to implement measures to protect the environment and disseminate alternatives to non-renewable energy sources [29]. Nowadays, society is becoming more and more aware of the expansion of ecological problems in the world. This influences the growing interest in generating energy from renewable resources [30], i.e., obtained from solar radiation, wind, biomass, water, and geothermal sources.

For any economy, one of the most important goals is to achieve energy security [31]. This term means the ability of the economy to reach a state that allows the current and future needs of consumers for fuel and energy to be met under market conditions [32]. Energy security for any country means that it must ensure the supply of sufficient electricity at a price that consumers are able to pay, while respecting the principles of conservation [33]. The definition of energy security is contextual and dynamic [34]. There is an increasing emphasis on dimensions such as environmental sustainability and energy efficiency [35].

The article poses the following research questions:

1. Have the examined companies made modifications to their areas of operation in order to implement sustainable production principles?
2. Have the examined companies implemented environmental management systems?
3. Have the examined companies used renewable energy sources in their operations?

The conducted argument in the introduction made it possible to formulate the following research hypothesis: the environmental efficiency of selected food processing enterprises results from optimizing the use of energy, water, waste disposal, and RES, being a consequence of national legal regulations in this area.

The importance of the study can be considered as a new contribution as it intends to identify, clarify, and assess the use of environmental management systems and renewable energy sources in selected food processing enterprises in Poland. In addition, the results can be helpful in creating a strategy for companies and sectoral economic policy programs, helping adjust the activities of related entities in the food market.

The article is composed of the following parts: Introduction, Materials and Methods, Results and Discussion, Conclusions, and References. In the Introduction, the concept of sustainable development, environmental management systems, and the issue of energy security has been presented. In the Materials and Methods section, the sample and procedure, as well as measures have been explained. The Results and Discussion show the structure of modified areas of activities in food processing enterprises in Poland, implementation of
chosen management systems, as well as cross-case studies on the implementation of the bioeconomy concept in the examined food processing enterprises in Poland. The summary points out the degree and directions of environmental efficiency in selected food processing enterprises, and the importance of the legislative aspects of the use of RES.

2. Materials and Methods

2.1. Sample and Procedure

Polish food processing is one of the most important and dynamically developing sectors of the national economy, with the percentage share of food sold production to GDP equal to 4% in 2018 [36]. In 2018, the Polish food processing sector was ranked 6th in the EU, after Germany (22%), Italy (13%), France (10%), Great Britain (7%), and Spain (6%) [36].

For the purposes of this paper, a structured questionnaire with a clearly defined research objective was used. The questions required answers about the state of the studied phenomenon in 2018 and 2010 in order to compare the changes occurring over time. The questionnaire survey covered 120 food processing enterprises in four processing areas: meat, dairy, bakery and confectionery, and fruit and vegetable. For the purpose of the study, a database of contact details of all food processing enterprises was built from PKD 2007 (ang. Polish Classification Activities 2007). Every entrepreneur has to choose at least one PKD code at the moment of establishing the company, so that the authorities know what type of business activities will be carried out within its framework. These are the main criteria for the selection of the research sample:

- Running food processing activity according to Polish Classification of Activities (PKD 2007/year);
- Site in the country;
- Active business operations;
- Processing and production capacity (t/week), number of full-employed workers, income value (PLN/year).

The study included companies relatively evenly distributed within the country. Then, a survey using the CAWI method (ang. Computer-Assisted Web Interview) was commissioned to one of the largest external market research companies. The questionnaires were sent to the email addresses of the offices of food processing enterprises every Monday at 6.00 a.m. for 8 consecutive weeks of the year from 1 January 2018 to 19 February 2018. The duration of the active part of the survey lasted 56 days. The duration of the passive part of the survey lasted from 1 January 2018 to 31 December 2018. This means that the collection of data lasted 356 days. The questionnaires were addressed directly to the production management departments. The received surveys were checked for data completeness. Only those surveys that were completed in full were used for analysis. In the questionnaire, there were questions checking the correctness of the answers given. In case of doubts as to the correctness of answers, such questionnaires were not subject to further analysis. In about 20–30 cases, the respondents called back the authors for follow-up information about the survey. Most often, after telephone reassurance about the veracity of the study, respondents returned completed surveys. In the course of the survey, the return of the online survey was about 22%. Therefore, out of the 545 questionnaires sent, 120 correctly completed questionnaires were used for research. The large size of the total collective of food processing enterprises provided a basis for the use of a sample survey method.

The authors have, as carefully as possible, eliminated the danger of unauthorized responses based on the expertise and trust between the subjects of the study, which is the foundation of all scientific research.

2.2. Measures

According to Creswell (2013) [37], surveys are qualitative, collected in a cleaned database, verified with analysis by means of statistical methods and a summary. Table 1 shows the presentation of the research subject, objects, and territorial and temporal scope of the study, along with measurement methods and tools.
Table 1. Presentation of the research characteristics.

| Research Subject | Objects, Territorial and Temporal Scope | Measurement Methods and Tools | Current Application of Methods |
|------------------|----------------------------------------|-----------------------------|--------------------------------|
| Assessment of environmental-efficiency | Database on enterprises running business in food processing sector in Poland | Questionnaire: CAWI technique Case-studies Statistical methods | To deepen and widen the analyses of environmental efficiency in food processing sector |

The analysis of the completed questionnaires in the pilot study showed that the respondents did not have difficulties in completing them, and that the adjustments made to the questionnaire were minor modifications and additions. The questionnaire prepared in this way was used in the main study, and the collected data were processed and analyzed.

The questionnaire was conducted in 2018 and consisted of different types of questions: (yes/no), multiple choice questions (a/b/c/d), Likert’s scale questions (1—least, 5—most) [38]. From the answers to the open questions of the questionnaire, a catalog of the surveyed enterprises’ activities in the field of renewable energy sources and circular economy was created. The questionnaire, which is shown in Appendix A, was enriched by cross-case comparisons and formal observations. Conducting research using the CAWI method reduces costs and time associated with the preparation of the survey itself, its implementation, and collection of data for analysis. In contrast to a paper survey:

- The electronic form allows the results of the survey to be viewed while it is in progress;
- It is low cost due to there being no need to hire interviewers;
- Questionnaires in electronic form are easier to correct in case a mistake is noticed after they have been prepared, and they do not require financial outlays connected with printing them;
- There is quick access to the obtained data and possibility of quick analysis;
- It eliminates the “pollster effect”, i.e., the influence of the person conducting the survey on the answers given and the participants can remain more anonymous;
- It is possible to reach groups that are difficult to reach in a traditional way. The theoretical basis for constructing the questions is reflected in the following literature [39–42].

The use of multiple sources of materials allowed triangulation of results, which belongs to the strength of the study [43]. The case study has become a common method of describing phenomena, events, and situations which may have a cognitive, educational, or promotional value on similar issues, applying similar methods, or those who are looking for inspiration for action. Case studies are also a good way to illustrate how theory works in practice [44].

3. Results and Discussion

Each manufacturing, as well as a processing enterprise to pursue a paradigm of sustainability and sustainable development, must avoid over-exploitation of components. The enterprise is obliged to commit to the environment, and to implement the measures that make up the greening process in its place. The greening process requires the application of four principles [45]:

- Minimizing the amount of raw materials needed for production, usually by using new technologies and recycling;
- Minimizing the amount of pollution and waste generated during production, by using closed circuits;
- Manufacturing of products or parts of products with a long service life, so that the use of new raw materials for production is shifted in time;
- Designing and organizing all stages of the production process for environmental protection.
3.1. The Validity of Structure of Modified Areas of Activities

Figure 3 shows the structure of modified areas of activities undertaken by chosen food processing enterprises in Poland, in order to improve the use of different kinds of resources.

| Number of owned means of transport | 10* | 18* |
|-----------------------------------|-----|-----|
| Small                             |     |     |
| Medium                            | 22% | 30.8% |
| Large                             | 23% | 38.5% |
| **Decreased**                     |     |     |
| **No Change**                     |     |     |
| **Increased**                     |     |     |

| Implementation of improvements and innovations | 10* | 18* |
|-----------------------------------------------|-----|-----|
| Small                                         | 33.4% | 66.7% |
| Medium                                       | 77% | 54% |
| Large                                        | 24% | 72% |
| **Decreased**                                |     |     |
| **No Change**                                |     |     |
| **Increased**                                |     |     |

| Use of technologies improving production processes | 10* | 18* |
|----------------------------------------------------|-----|-----|
| Small                                              | 33.4% | 66% |
| Medium                                             | 32% | 64% |
| Large                                              | 24% | 72% |
| **Decreased**                                     |     |     |
| **No Change**                                     |     |     |
| **Increased**                                     |     |     |

| Use of the machinery and technology park | 10* | 18* |
|------------------------------------------|-----|-----|
| Small                                    | 37% | 63% |
| Medium                                   | 61.5% | 38.5% |
| Large                                    | 54% | 16% |
| **Decreased**                           |     |     |
| **No Change**                          |     |     |
| **Increased**                          |     |     |

Figure 3. The structure (%) of modified areas of activities in food processing enterprises in Poland. 10*—2010 year, 18*—2018 year.

In 2010 and 2018, the most frequently introduced changes in the functioning of all analyzed size groups of food processing enterprises was a search for increasing the number of improvements and innovations. In 2010, for 72% of medium-sized and 66.7% of large food processing companies, the key to improving their operations was the introduction of improvements, mainly organizational and innovations in the production process. The second, equally strongly modified area of functioning, indicated by 64–66% of medium-sized and large food processing companies and 38% of small businesses, resulted from the increased use of technologies which improved the production processes. The implementation of so-called “modern” investment technologies, which are rationalizing the consumption of raw materials, materials and energy played the decisive role. The third area indicated in 2010 by 60% of large and 60% of medium-sized food processing companies, and in 2017 by 72% of large and 72% of medium-sized food processing companies, was an increase in the use of the machinery and technology park. This was due to the basic action to reduce material intensity and optimize the design of machines and equipment, technologies, and products. In 2010, 54%, and in 2017, 83.5% of small food processing companies did not introduce changes in the use of the machinery and technology park. As the only ones, they...
have intensively increased their means of transport from 7.7% (2010) to 23% (2018) and, thus, extended the territorial impact area.

3.2. The Declarations of Respondents Concerning the Implementation of Management Systems in Examined Food Processing Enterprises in Poland

Figure 4 shows that, in 2010, 40 enterprises were Hazard Analysis and Critical Control Point (HACCP) (from 1 January 2006 the EC Regulation no. 852/2004 is in force in Poland, being a part of the so-called hygiene package, which is addressed to all food companies. In article 5 of the regulation, there is a requirement to develop, implement, and maintain a permanent procedure on the basis of HCCP principles) certified, 26 surveyed enterprises claimed to be Good Manufacturing Practices (GMP) certified, 21 of them were ISO 9001 certified, and 11 surveyed food processing enterprises had implemented CIP. The interest of the surveyed companies in implementing an EMS according to EMAS was low, with one company in 2010 and 2018.

![Figure 4](image)

**Figure 4.** Implementation of chosen management systems by food processing enterprises in Poland. Presentation of “yes” answers only.

In 2018, 56 food processing enterprises in Poland had the HACCP system, 29 of them implemented the GMP system, and 21 of them implemented the Quality Management System (QMS) in accordance with the requirements of ISO 9001. The implementation of the CIP practice was declared by 10 surveyed enterprises. To sum up, during the eight years of analysis, the establishments did not intensify their activities aimed at increasing the number of implementations of environmental management systems.

It may be puzzling that such a small number of examined enterprises declared having HACCP and CIP certificates, which are directly dedicated to enterprises in the food sector. Lack of such certificates prohibits conducting business in the field of food production and processing; therefore, authors believe that establishments have provided false information in this regard because, since 28 October 2008, the Act on Food and Nutrition Safety [46] is in force in Poland, which replaced the Act of 11 May 2001 [47] on health conditions of food and nutrition. According to the Act of 2008, anyone who does not implement the principles of the HACCP system in a food production or trade facility—contrary to the obligation specified in Article 5 of the Regulation EC No. 852/2004 [48] on the hygiene of foodstuffs—is subject to a fine (Article 100 of the Act on food and nutrition safety). The act has a framework character and comprehensively regulates conditions necessary to ensure food safety at all stages of the food chain “from the field to the table” [49].
Only 2 out of 120 surveyed food processing companies declared having ISO 50,001 certification, which enables the achievement of higher economic benefits related to the improvement of energy efficiency of the processes and installations implemented, and is characterized by a greater focus on regulations on the energy aspects of operations. The results of the undergone analysis are consistent with the research conducted by Janowicz et al. 2017 [50], which shows that the implementation of an energy management system according to ISO 50,001 is not common (only 7% of answers). In addition, they indicated that no ISO-based energy management system is implemented in food industry companies in the rest of the respondents (73%). Walker et al. [51] point out that the implementation of an energy consumption monitoring system enables daily profiling of energy consumption.

Figure 5 shows the declared reasons for implementing management systems in surveyed food processing companies. During the eight year analysis period, food processing companies ranked the need to comply with legislation as the most important reason for implementing quality and safety assurance systems, as well as environmental management, which was rated 4.30 points on a five-point scale in 2018, and 3.85 points in 2010. In second place was classified as maintaining market position, which was rated at 4.09 points on a five-point scale in 2018. In third place was improving the image of the plant, which was assigned 4.03 points on a five-point scale in 2018. In contrast, improving the image of the establishment was ranked second, with a score of 3.52 points, in 2010, and maintaining market position was ranked third, with a score of 3.44 points. The decision of the surveyed food processing enterprises in Poland in 2010 regarding a slightly higher rating of company image over maintaining market position is due to the fact that an increase in the perception of company image by contractors and consumers helped to improve their competitiveness and, thus, affected the maintenance of market position.

Respondents indicated that the implementation of quality and safety, as well as environmental management systems in examined food processing enterprises was an activity that improved their functioning in the area of environmental efficiency, leading to an increase in the efficiency of the production process, increasing the transparency of management systems [52,53], as well as a decrease in the consumption of raw materials per kilogram of finished product [54].
3.3. Cross-Case-Studies on the Use of Renewable Energy Sources in Food Processing Enterprises in Poland

The bioeconomy includes the production and processing of renewable biological resources and the conversion of the resulting waste into value-added products, i.e., food, feed, bioenergy, and bio-based products [55]. The agro-food industry uses raw materials of plant and animal origin for further processing, which become contributors to the transformation of materials and energy in the ecosystem. Table 2 shows linkages between agriculture, livestock production, and facilities of chosen industries in terms of major material and energy flows, along with waste and pollution emissions. Processing companies procure raw materials and energy carriers for production. In the production process, main products, as well as residues of various chemical compositions and substances, are manufactured.

The residues of the main production can be used in other productions, e.g., fusel, molasses, decoction, organic fertilizer. Biogas can come from wastewater treatment plants, as well as organic processing from livestock production. Recalled bread and other expired carbohydrate products can be processed at a distillery. To a small extent, sugar-rich apple pomace can be used as a substrate in alcoholic fermentation.

The concept of bioeconomy is often associated with biomass production, and is considered as the main link in the bioeconomy value chain [56]. The bioeconomy of a circular economy becomes a part of the European Strategy for building sustainable economy [57]. Germany developed its national program implementing the bioeconomy, that is National Research Strategy BioEconomy 2030. In Poland, the bioeconomy aspects are fragmentarily mentioned in the Medium-Term Strategy for the Development of the Country (known as: Strategia Rozwoju Kraju 2020) [58]. It has to be emphasized that the agricultural regions of Poland bind their future to the use of natural resources [59].

Table 2. Cross-case studies on the implementation of the circular economy in surveyed food processing enterprises in Poland.

| No. | The Implementation of the Bioeconomy Concept in Chosen Food Processing Enterprises in Poland |
|-----|------------------------------------------------------------------------------------------|
| 1.  | Processing of slaughterhouse waste | A practical example of minimizing the cost of slaughterhouse waste processing is the use of so-called inedible byproducts in a biogas plant. The most common form of processing waste from industrial meat processing was the production of meat and bone meal, fat, and soil improvers. One of the alternative methods of utilization of slaughterhouse waste utilization, with a high content of organic matter, was to use the waste as a raw material for biogas production. |
| 2.  | Production of biogas | In 2013, a biogas plant was launched at Zakłady Mięsne Mróz SA in Bo-rzeciczki in Wielkopolska. The fermenter is fed with slaughterhouse waste and corn silage from the company’s own crops. Every day, 30 tons of substrate is produced [60]. Reducing the cost of waste disposal, and for the local community—reducing the nuisance of fetor from the piggery is a component of a package of solutions for building a closed-circuit economy, including activities that reduce the negative impact of the product life cycle on the environment. |
| 3.  | Own heat and power plant | The Piątnica Co-operative is the biggest producer of granular cheese worldwide. In 2011, the ecological dimension of the development enterprise of the Piątnica Dairy Co-operative started own heat and power plant, working on high-efficiency cogeneration. Electricity production is linked to heat production. The electricity demand of the plant is fully covered. The heat demand of the plant is covered to a large extent. The high energy efficiency of the equipment and the avoidance of transmission losses result in a high level (at least 75%) of use of the primary energy contained in the gas fuel [59]. |
| 4.  | The purification and reuse of process water | The Piątnica Co-operative minimized the environmental effect of processing process by introducing the purification and reuse of process water. It led to significant reduction of water consumption approx. 240 m³/day. |
Table 2. Cont.

| No.  | The Implementation of the Bioeconomy Concept in Chosen Food Processing Enterprises in Poland |
|------|------------------------------------------------------------------------------------------------------------------|
| 5.   | Own sewage treatment plant | The Piątnica Co-operative cleans wastewater from the production in its own sewage treatment plant. After the modernization in 2012, the sewage treatment plant can clean up to 2500 m³ of sewage per day, which covers the needs of the production site for next years. |
| 6.   | Distillery stillage | Distillers’ stillage is a waste from the production of bioethanol from various feed stocks, in particular, from grain. Distillers’ stillage can occur in dry, wet, liquid form. Its high nutritional value is due to its protein content. Nutritional value is high due to its protein content. Increasingly better processing technologies for grain broths have made them more consistent in composition and they are successfully used in swine feed. Individual farms working with meat processing companies choose to incorporate distillers’ stillage into pig feed. Depending on the type of grain used for fermentation, the metabolic energy of the distillery stillage varied from 10.5 to 14 MJ/kg. Studies have shown that the high insoluble fiber content of distillers’ broth in feed can benefit gut health and fattening pigs through changes in cell proliferation, digestive viscosity, and microbiome. Preliminary results suggest that, compared to soybean meal and corn, distillers’ broth has a lower risk of PED (porcine epidemic diarrheal) virus survival and does not appear to be a significant risk factor for ASF virus transmission. |
| 7.   | Implementation of ISO 14001 | The Piątnica Co-operative implemented ISO 14001 standards. |
| 8.   | Expenditures on pro-environmental policy | Zakłady Mięśni Mielczarek sp. z o.o. sp. komandytowa actively participates in the environmental policy by developing and implementing the improved HACCP, GMP/GHP systems, which guarantee food health safety. In 2002, ZM Mielczarek was granted permission to trade with EU countries. The plant complied with the required environmental protection regulations. The expenses related to the protection of the environment and the surroundings of ZM Mielczarek include: - expenditures on pro-ecological investments, e.g., a modern plant not emitting harmful fumes, a modern car fleet, waste segregation, optimal use of bulk packaging, fixed costs incurred by the company for using the environment, paying monitoring costs, payments for waste management. |
| 9.   | Expenditure on pro-environmental investments | The priority action of Delikatesy Mięśnie Gzella Sp. z o.o. is to actively work on limiting the negative impact of the company on the environment and to rigorously comply with regulations in force in Poland concerning its protection. The scope of the company’s activities is related to production processes, which could have a negative impact on natural resources (water, air, soil). In Delikatesy mięśnie Gzella, a key role is played by specialized Teams for Environmental Monitoring and Analysis and systematic work on introducing new even safer production and storage technologies. Expenses related to the protection of nature and surroundings of Delikatesy Mięśnie Gzella sp. z o.o. can be divided into: expenditures on pro-ecological investments, e.g., modern plant not emitting harmful fumes, modern car fleet, waste segregation, optimal use of collective packaging, introduction of paper bags and cloth bags instead of plastic bags in the entire chain of Delikatesy Mięśnie Gzella Sp. z o.o. |
| 10.  | Innovations in food packaging | It is beneficial to introduce innovations in food packaging designed to increase barrier properties and extend shelf life of perishable products, i.e., meat [61]. It is important to reduce losses at the stage of industrial food production as a result of reliable verification of losses and setting plant standards at a minimum level [62]. Optimization of food production, storage, and transportation allows to minimize the amount of unsold products, the only form of return of which is to undertake the “complaint process”. |

Figure 6 shows a model of the circular economy with the use of renewable energy sources in surveyed food processing enterprises.
The idea of a closed-cycle economy directs economic activities towards closing the life cycle of each product, aiming at its final use [63]. Up to now, the sequence from cradle to grave, i.e., production—use—waste utilization, has been applied. Closed loop is based on creating a sequence from cradle to cradle, i.e., production—use—utilization of waste in the next production cycle [64]. In December 2018, the recast Renewable Energy Directive 2018/2001/EU entered into force, as part of the Clean Energy for all Europeans package, aimed at keeping the EU a global leader in renewables and, more broadly, helping the EU to meet its emissions reduction commitments under the Paris Agreement [65]. From 2010 up to now, enterprises are choosing energy-efficient devices to minimize energy consumption for production purposes [66,67].

4. Conclusions

Sustainability is a fundamental component of building market advantages of the analyzed enterprises. It is noticeable that companies are moving away from traditional, short-term action strategies to provide customers with more sustainable products. Increased environmental awareness of customers is associated with their participation in product development [68].

In the article, the hypothesis has been positively verified. The results of the research have made it possible to put forward specific conclusions on the degree and directions of environmental efficiency in selected food processing enterprises in Poland. In particular:

**Figure 6.** Model of circular economy with the use of renewable energy sources in food processing enterprises.
1. Enterprises as key factors influencing the improvement of functioning recognize the implementation of improvements and innovations, and the introduction of new or ‘knowledge-intensive’ technologies. Attention has been drawn to the need for more efficient use of the machinery and technology park.

2. The main factors motivating companies to implement measures is the need to comply with the legal provisions in terms of environmental protection.

3. All analyzed food processing enterprises strongly referred to environmental aspects of their operations. A total of 80% of the analyzed enterprises stressed an impact on the public.

4. The examined food processing enterprises should focus on measures to improve the environmental performance through:
   - Shaping the potential and development of areas for the implementation of environmental measures;
   - Seeking solutions to further reduce pollution levels in the atmosphere by installing gas boilers and filters, reducing emissions of pollutants into the atmosphere.

5. Among the planned actions of the EC’s new package on a circular economy are [68]:
   - Development of environmental standards for secondary raw materials to facilitate their identification and increase their potential for use in the single market;
   - Implementation of a plastics strategy on recycling, biodegradability, and presence of hazardous substances in plastics;
   - Actions to reduce food waste, including the development of a common measurement methodology, improved labelling of expiration dates, and tools to achieve the sustainable development goal of halving food waste by 2030;
   - Amending the Fertilizer Ordinance to make it easier to identify organic and waste-based fertilizers in the single market and to promote the importance of biological nutrients;
   - Action on water recycling, including a legislative proposal on minimum requirements for secondary use of waste water.

To summarize, the use of renewable energy sources must be subject to systematic environmental impact assessment. Legislative recommendations for state authorities concern informing investors about the necessity of RES environmental impact assessment procedures in spatial development plans and public participation before RES construction begins.

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Table A1. The example of a survey template.

| Number of Question in a Questionnaire | Answer Options |
|--------------------------------------|----------------|
| 1. Number of modified areas of activities undertaken by chosen food processing enterprises classified as: (a) use of the machinery and technology park (b) use of technologies improving production processes (c) implementation of improvements and innovations (d) number of owned means of transport | Give answers to all answer options by assigning a score from 1 to 5, where: 1 is the most important and 5 is the least important. |
| 2. Implementation of chosen Management Systems by food processing enterprises: (a) EMAS (b) ISO 14 001 (c) ISO 9 001 (d) ISO 22 000 (e) ISO 31 000 (f) ISO 50 001 (g) HACCP (h) GMP (i) CIP (j) others | Give answers to all answer options by assigning those which are implemented. |
| 3. Declared reasons for implementing Management Systems in food processing enterprises: (a) necessity to adapt to legal regulations (b) reducing production costs (c) maintaining market position (d) enlarging the market into a new group of consumers (e) expanding the market into a new area (f) improving the company’s image (g) creating an efficient and transparent management (h) improving the quality of the product range | Give answers to all answer options by assigning a score from 1 to 5, where: 1 is the most important and 5 is the least important. |
| 4. Use of renewable energy sources in food processing enterprises: (a) processing of slaughterhouse waste (b) production of biogas (c) own heat and power plant (d) the purification and reuse of process water (e) own sewage treatment plant (f) distillery stillage (g) implementation of ISO 14 001 (h) expenditures on pro-environmental policy (i) expenditure on pro-environmental investments (j) innovations in food packaging | Give answers to all answer options by assigning those which are implemented. |

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