

## **CULTIVATION OF ENERGY CROPS IN LINE WITH SUSTAINABILITY**



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## **Abstract**

The research objective of this paper is to answer the question of whether obtaining energy from biomass is consistent with sustainable development indicators. A new direction of regional policy was proposed, which is the cultivation of energy crops. The demand for clean energy is now a key global issue where global ideas are being implemented through local action. Drawing on a global sustainability science and practice perspective, we provide the use of biomass for energy purposes, justified through the analysis of three selected indicators of the pillars of sustainable development: the exposure of the urban population to the excessive effects of PM10, eco-innovation, greenhouse gas emissions in CO<sub>2</sub> equivalent. Using these indicators, we found that the cultivation of energy crops is consistent with the objectives of sustainable development and gives the opportunity to activate the rural society. The use of biomass for energy purposes enables the achievement of eight goals belonging to the three pillars of sustainable development: goal 2 zero hunger; goal 3 good health and well-being; goal 7 affordable and clean Energy; goal 8 good jobs and economic growth; goal 9 industry, innovation, and infrastructure; goal 10 reduced inequalities; goal 12 responsible consumption and production: ensure sustainable consumption and production patterns; goal 13 climate action: take urgent action to combat climate change. The improvement in the economic situation of the inhabitants of rural areas can be seen in additional employment in the alternative energy sector. It is shown that a compromise in achieving the SDGs is possible by putting in place an appropriate energy policy that reconciles the interests of economics, ecology, and man. We conclude our paper by discussing the results of our research and their implications for the country's environmental and energy policies.

**Keywords:** Biomass, Sustainable Development, Renewable Energy

## **1. Introduction**

The concept of sustainable development comprises a global approach to economic, social and environmental phenomena combined with identification of interrelations between them, the choice of developmental priorities when the economic, environmental, and social criteria are applied, as well as treating the natural environment as an entity that evolves and is subject to changes (in most cases anthropogenic changes) [1]. The crucial thing is to preserve natural assets (natural capital) as they are, or even to improve their status. A major problem of the modern society is the actual implementation of the sustainable development strategies that have been promoted by scientists, environmentalists, and politicians during scientific conferences and meetings held all around the world. The most important factors affecting such strategies are: environmental protection, economics, and sociology, while their main goal in the last decades has been the harmonisation of these

factors [2,3]. For this goal to be achieved, the public must firmly embrace the concept of sustainable development [4].

We are fascinated by technical progress, we proudly look into the future, mastering and transforming the Earth and nature. The possibilities of technology have no limits, and the implementation of new ideas is only a matter of time. We see wildlife as something that can be tamed, mastered, and exploited. This approach has brought us enormous benefits, but we are already losing our balance. We need a planetary impact constraint model. The steps to be taken must be comprehensive and system-wide. Sustainable coexistence with nature has become our only option. We cannot cross borders. We need to stop and reverse climate change, stop greenhouse gas emissions, stop the overuse of artificial fertilisers, stop grabbing more land for agriculture, stop ozone depletion, stop freshwater consumption, air pollution, and ocean acidification [5]. Nature will benefit from this and we will benefit from it because it is due to nature that the earth's environment is stable. Sustainable development in all areas should be our main goal.

## **2. Energy from renewable sources**

The primary goals of EU climate and energy policy are improving energy efficiency and increasing the share of renewable energy in the total energy balance of the European Union. Every country's energy policy is based on the strategy of balancing the safety of energy materials supply, effectiveness of economic processes and environmental protection.

Energy from renewable sources means energy from natural processes, and energy produced from non-fossil energy sources. The reserves from these sources complement each other in natural processes, making them inexhaustible [6]. The European Green Deal [7], which provides guidance for a sustainable eco-friendly transformation, plans that by 2050 Europe will become the world's first climate-neutral continent. With the forecast that energy consumption will continue to grow, the energy sector needs to be reoriented in such a way as to cover demand and minimise the adverse impact on the climate. The development of alternative energy technologies provides energy stability to the country because of the diversification of energy producers' offers.

Biofuels are divided into gaseous, liquid, and solid. Gaseous include biogas, obtained in the process of anaerobic fermentation of biomass, which consists mainly of methane. Wood gas, which is produced in the wood gasification process, is also a biofuel. Liquid biofuels include biodiesel, bioethanol, methanol and butanol, and vegetable oil.

Solid biofuels are all types of processed and unprocessed biomass that are used as fuel to produce heat or electricity. Biofuels include firewood (chips, wood briquettes, pellets and forest waste, shavings, sawdust), charcoal, energy crops (fast-growing trees, perennials, perennial grasses, cereals grown for energy purposes) and organic residues from agriculture and horticulture (e.g. horticultural production, animal waste, straw) [8]. Biodegradable fractions of municipal waste and peat (dried and possibly briquetted) are also considered to be solid ecological fuels.

The energy production of biomass is decentralized and does not require the construction of power lines. In comparison to the energy produced using conventional methods, it supports economical water management. The production costs of biomass energy are comparable to the costs of producing electricity from the power grid. It should be pointed out that in the poor and developing countries it allows one to improve hygiene and health conditions through the cessation of spilling fecal matter directly onto the fields, which has once been a cause of dangerous diseases epidemics.

There are not many flaws in this kind of energy production, but they are significant. The calorific value of biomass is two times lower than that of hard coal. Biomass processing installations are capital-intensive investments (high investment costs during the construction phase). Furthermore, it is necessary to strictly follow the fermentation regimes (temperature, acidity, and hermetic conditions during the processes). The biomass is usually highly moist which causes problems during its transport and storage. Bio-fuels production requires higher capital expenditures in comparison to the fuels produced during oil processing. Additionally, there are no tax exemptions for the producers of biomass energy [9, 10].

Below is an analysis of the implementation of the assumptions of selected indicators of the social, economic, and environmental pillars by the energy sector based on biomass.

### 3. The research methods

We used representative indicators for each pillar we had selected. The selection of indicators was dictated by the following criteria: the indicator should show everyday life in regional social policy, achieving the indicator has a measurable impact on improving the condition of the environment, i.e. regional environmental policy. The analysis of a selected indicator reflects one specific aspect of a broader sustainable development goal. We decided to choose these indicators, which are achieved directly or indirectly in energy policy, particularly in renewable energy. We analyzed all the sustainable development goals and showed which goals can be achieved thanks to the implementation of the selected indicator. The research was conducted using the following methods: an examination of documents, an examination of individual cases, analysis, and logical construction. The research technique consisted of observation and analysis of documents.

### 4. Implementation of pillars' indicators

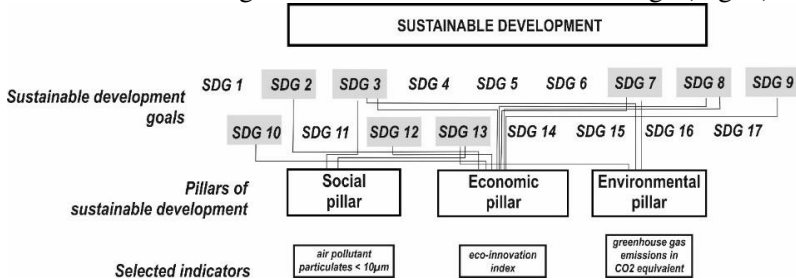
#### 4.1. Implementation of social pillar indicator

**Indicator:** the exposure of the urban population to the excessive effects of PM10 (domain: public health) is shown by the annual weighted average concentrations of PM10 at urban background stations located in agglomerations. Particulate matter is a mixture of very small solid and liquid particles, composed of organic and inorganic compounds. Contaminants in the air have a negative effect on human health, causing many respiratory and circulatory problems. Despite the actions taken to reduce PM10, exceeding the standards is one of the most important air quality issues in Poland. Out of 46 zones subject to air quality assessment in Poland in terms of average 24-hour PM10 pollution, exceedances of the admissible level were found in 38 zones. In most zones the limit values for PM10 and PM2,5, and benzo(a)pyrene are exceeded [11].

Biomass contains on average four times more oxygen compared to thermal coal and twice less carbon, but also less sulphur, nitrogen, and ash (on average 5 to 10 times less depending on the type of biomass). Moreover, it is characterised by a high volatile matter content (65-80%) and high reactivity that determine the need to use appropriate technical solutions guaranteeing its energy-efficient processing. The consequence is a higher proportion of emitted PM10

and PM2.5 particles, however, biomass fly ash contains significantly less metal atoms (Ti, Al, Fe) in the elemental composition than coal fly ash [9]. On the other hand, when burning biomass much more charcoal is released into the atmosphere than when burning conventional fuel [12,13].

Thanks to the implementation of the indicator: the exposure of the urban population to the excessive effects of PM10, the following goals can be achieved: goal 3 good health and well-being: ensure healthy lives and promote well-being for all of all ages; goal 13 climate action: take urgent action to combat climate change (Fig. 1).



**Fig. 1.** Implementation of sustainable development goals through the use of biomass as an energy source

#### 4.2. Implementation of economic pillar indicator

**Indicator:** eco-innovation (domain: innovation) is based on 16 indices from five areas: three of them directly relate to eco-innovation. These are: inputs, activities, and results. The other two groups of indices are the effects of introducing eco-innovation: environmental and socio-economic effects. Innovation means a new or significantly improved product, process, organisational or marketing method, which bring environmental benefits compared to alternative solutions. Innovation is strongly linked to sustainable development. Eco-innovation slows down the exploitation and use of natural resources and the release of harmful substances into the environment. They benefit the economy by increasing the competitiveness of enterprises.

An example of an eco-innovation process is the use of biomass in energy production. By using biomass in the power industry we prevent waste of food surpluses, manage production waste from the forestry and agricultural industries, and dispose of municipal waste

[11]. However, Poland is one of the least eco-innovative countries in the European Union: in 2018 our country was ranked only 26th among 28 countries in the Community [14].

Thanks to the implementation of the indicator: eco-innovation, the following goals can be achieved: goal 2 zero hunger: end hunger, achieve food security and improved nutrition, and promote sustainable agriculture; goal 7 affordable and clean energy: ensure access to affordable, reliable, sustainable and modern energy for all access to clean fuels and technologies for cooking; goal 8 good jobs and economic growth: promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all; goal 9 industry, innovation and infrastructure: build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation; goal 10 reduced inequalities: reduce inequality within and among countries the Gini coefficient; goal 12 responsible consumption and production: ensure sustainable consumption and production patterns (Fig. 2).

#### *4.3. Implementation of environmental pillar indicator*

**Indicator:** greenhouse gas emissions in CO<sub>2</sub> equivalent determine total annual man-made greenhouse gas emissions in relation to the base year 1988, in accordance with the Kyoto Protocol. The Kyoto basket encompasses the following six greenhouse gases: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and F-gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>). Greenhouse gas emissions are defined as the aggregated emission of the six greenhouse gases listed, weighted by global warming potentials on a 1988 basis equal to 100 [15]. The carbon dioxide equivalent shall be 1 Mg or an amount of another greenhouse gas equivalent to 1 Mg of carbon dioxide calculated using global warming potentials, e.g. one tonne of methane corresponds to 25 tonnes of CO<sub>2</sub>. The Kyoto agreement is considered one of the first steps of the international community toward formalised action for effective environmental protection. After the ratification of the Kyoto Agreement, Poland adopted several documents and implemented new regulations on energy development and climate protection, such as the Polish Energy Policy until 2030 [16], the National Energy and Climate Plan 2021-2030 [17], the Polish Energy Policy until 2040 [18] and the Polish Energy Policy until 2050 [19].

Thanks to the implementation of the indicator: greenhouse gas emissions in CO<sub>2</sub> equivalent, the following goals can be achieved: goal 3 good health and well-being: ensure healthy lives and promote well-being for all of ages; goal 7 affordable and clean energy: ensure access to affordable, reliable, sustainable and modern energy for all access to clean fuels and technologies for cooking; goal 13 climate action: take urgent action to combat climate change (Fig. 3).

## **5. Conclusions**

The main objective of energy policy is to ensure the country's energy security, to increase the competitiveness of the economy and its energy efficiency, and to protect the environment.

The use of alternative energy sources can be a good solution in the situation of a huge ecological crisis in the world. Biomass is the most widely used unconventional energy source in the world. This is an opportunity to improve the condition of the environment. The strategy highlights that improved energy efficiency will reduce dependence on energy imports, reduce emissions, and drive jobs and growth, especially in a rural environment. The improvement of the economic situation of the inhabitants of rural areas can be achieved by providing additional employment, which is the cultivation of energy crops.

Preserving the natural capital at the current or higher level is possible by implementing in place an appropriate environmental and energy policy of the country.

The analysis of selected indicators of sustainable development showed that thanks to the use of biomass as an alternative source of energy, it is possible to achieve as many as eight goals: zero hunger; good health and well-being; affordable and clean energy; good jobs and economic growth; industry, innovation, and infrastructure; reduced inequalities; responsible consumption and production: ensure sustainable consumption and production patterns; climate action: take urgent action to combat climate change.

A very important element of the pro-ecological regional policy is the information and education campaign for society. The implementation of sustainable development indicators must be rooted in social consciousness, as environmental education is a factor of fundamental importance for environmental protection and preservation for future generations.



Sustainable development in the energy sector means finding a conflict-free relationship between the social, economic, cultural, and natural aspects of energy generation technology. Poland has one of the largest potentials for renewable energy resources in the EU. In order to be able to use it, it is necessary to increase financial outlays on research and development of technology and create a system of co-financing projects. Actions should be modeled on the European Union, which has been supporting the development of renewable energy sources for many years.

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Wiktoria Sobczyk and Eugeniusz Jacek Sobczyk authored the project and designed the study; Wiktoria Sobczyk, Maciej Ciepiela and Oksana Nagornuk contributed to the study design and discussed the data; Maciej Ciepiela, Svetlana Yashnyk and Oksana Nagornuk revised the data; Wiktoria Sobczyk and Eugeniusz Jacek Sobczyk wrote the original draft of the paper; all authors contributed to the manuscript final form and approved the version to be submitted.

### **Conflict of interest statement**

The authors declare no conflict of interest.

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