



STATE OF PLAY FOR

# BIOECONOMY IN THE SOUTH BALTIC AREA





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# Polish regional bioeconomy potential

## West Pomeranian, Pomeranian and Warmia and Mazury regions

As mentioned earlier, implementation of Strategy for Innovation and Efficiency of the Economy (SIEE) in the Polish South Baltic Area is based on individual, regional strategies. All three Baltic neighbouring regions have developed their own regional strategies and fortunately they focus on similar issues such as<sup>1 2 3</sup>:

- higher energy efficiency, especially in electricity production and energy transmission, together with rationalization of its use;
- high level of use of renewable energy resources, mainly in the distributed generation system;
- lower costs of using energy;
- better air quality;
- innovative solutions implemented in power engineering, including smart grids;
- high public awareness of the need to rationalize energy consumption and the impact of energy on the quality of the environment and living conditions, as well as common consumer attitude.

The primary focus of the ESES and NDS is on energy resources and water, and for ESES there is also a focus on timber. All strategies focus on the increase in three areas: competitive and innovative economy, effective and robust state, and demonstration of the differences in development of the provinces.

The main objective of the medium-term strategy is to strengthen and make use of the economic, social and institutional capabilities in order to ensure rapid and sustainable development of the country, and to improve quality of life<sup>4</sup>.

### Regional strengths and weaknesses

Poland is divided into 16 regions, called voivodeships (provinces). Three of them are in the South Baltic Area, i.e. West Pomerania, Pomerania and Warmia and Mazury Regions.

According to the data provided by EUROSTAT, bioeconomy is already one of the largest and most important components of the Polish economy. Gross value added in bioeconomy sectors in the years 2009-2013 had an annual average of about € 63,5 billion, representing more than 19% of gross value

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<sup>1</sup> Strategia rozwoju Województwa Pomorskiego do roku 2020 (Strategy for development of Pomeranian Region by 2020)

<sup>2</sup> Strategia rozwoju Województwa Zachodniopomorskiego do roku 2020 (Strategy for development of West-Pomeranian Region by 2020)

<sup>3</sup> Strategia rozwoju społeczno-gospodarczego Województwa Warmińsko-Mazurskiego do roku 2025 (Strategy for development of Warmia and Mazury Region by 2025)

<sup>4</sup> Strategia Rozwoju Kraju do roku 2020 Aktywne społeczeństwo, konkurencyjna gospodarka, sprawne państwo (National Development Strategy 2020 Active society, competitive economy, efficient state, Warsaw, September 2012)

added produced in the national economy. The bioeconomy sector in Poland employs more than 4,7 million people, representing more than 30% of employees in the whole economy.

Biomass production sectors (agriculture, forestry and fisheries) and the sectors entirely based on raw materials of biological origin (food industry, production of beverage, tobacco industry, wood and paper industry) are also very important segments of the Polish economy. Their share in the gross value added of the Polish economy in the years 2009-2013 was about 7,5%, while in terms of employment it was about 17,5%. Agriculture and agro-food industries are the most important nodes of the Polish bioeconomy<sup>5</sup>.

Table 1. Land structure in Polish South Baltic Area

Land	Pomeranian Region <sup>6</sup>		West Pomeranian Region <sup>7</sup>		Warmia and Mazury Region <sup>8</sup>	
Agriculture [k ha]	759,9	41,5%	837,1	36,6%	994,6	41,1%
Forestry [k ha]	683,4	37,4%	813,8	35,5%	753,3	31,2%
Fallow land [k ha]	4,9	0,3%	13,1	0,6%	7,1	0,3%
Urbanized [k ha]	97,2	5,3%	101,1	4,4%	93,1	3,9%
Other [k ha]	283,9	15,5%	524,1	22,9%	569,2	23,5%
<b>Total [k ha]</b>	<b>1.829,3</b>	<b>100%</b>	<b>2.289,2</b>	<b>100%</b>	<b>2.417,3</b>	<b>100%</b>

The Pomeranian Region is located in the middle of the Polish South Baltic Area. The territory of the Region is 1.829.300 ha, which makes the region the eighth largest in Poland. The region is divided into 16 powiats (counties), 123 municipalities and 8 towns with the status of municipality. The population is approximately 2.309.400 inhabitants (eighth in the country) and the region covers a land area of 1.829.300 ha (5,9% the area of Poland). The number of farms is approximately 60.900 and the area with arable land is 759.900 ha.<sup>9 10</sup>

The population density in the region is 126 people per square kilometer. On the territory of the region there are practically no natural resources except for sand, gravel and clay. The region features a significant amount of forests, amounting to 36%, whereas the average forestation of the country is about 28%. Soils in the region have rather low fertility, except for the area of Żuławy Wiślane (fen soils).

The Warmia and Mazury Region is located in the east part of the Polish South Baltic Area and consists of 116 municipalities. The population is approximately 1.443.967 inhabitants and the region covers a land area of 2.417.300 ha (7,7% the area of Poland). The number of farms is approximately 41.700 and the area with arable land is 994.569 ha.<sup>11 12</sup>

<sup>5</sup> Bioeconomy in Poland: Condition and potential for development of the biomass market Jarosław Gołębiowski Warsaw University of Life Sciences, Poland

<sup>6</sup> Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

<sup>7</sup> Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

<sup>8</sup> Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

<sup>9</sup> Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

<sup>10</sup> Plan gospodarki odpadami dla województwa pomorskiego 2022

<sup>11</sup> Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

The West Pomeranian Region is located in the west part of the Polish South Baltic Area and consists of 114 municipalities. The population is approximately 1.715.431 inhabitants and the region covers a land area of 2.289.200 ha (7,3% the area of Poland). The number of farms is approximately 29.700 and the area with arable land is 837.100 ha.<sup>13 14</sup>.

Table 2. Crop products (ha) in Polish South Baltic Area

	<b>Cultivated area (ha) West Pomeranian region<sup>15</sup></b>	<b>Cultivated area (ha) Pomeranian region<sup>16</sup></b>	<b>Cultivated area (ha) Warmia and Mazury region<sup>17</sup></b>
Total wheat	164.111	598.626	150.888
Rye	51.966	51.386	27.031
Total barley	46.280	32.837	32.131
Oats	21.122	24.634	19.010
Triticale	69.724	77.878	85.995
Cereal mixed	7.099	34.994	37.150
Potatoes	11.661	17.693	9.355
Sugar beets	9.448	9.211	2.060
Feed	43.073	52.021	102.816
Oilseeds	115.699	79.345	77.735
Vegetables	2.873	7.335	3.052
Tree fruit	11.044	2.857	4.346
Fruit bushes and berry fruit	6.007	2.861	4.773
<b>Total cultivated area</b>	<b>560.107</b>	<b>991.678</b>	<b>556.342</b>

In Fig. 1 There are the dominant types of bio-industry and agriculture in Polish SBA. As we be seen, poultry and fruits, accompanied by selected vegetables and triticale, are major types of bioindustry in the SBA regions.

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<sup>12</sup> Plan gospodarki odpadami dla województwa warmińsko-mazurskiego na lata 2016-2022

<sup>13</sup> Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

<sup>14</sup> Plan gospodarki odpadami dla województwa zachodnio-pomorskiego na lata 2016-2022

<sup>15</sup> Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

<sup>16</sup> Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

<sup>17</sup> Statistical Yearbook Warminsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

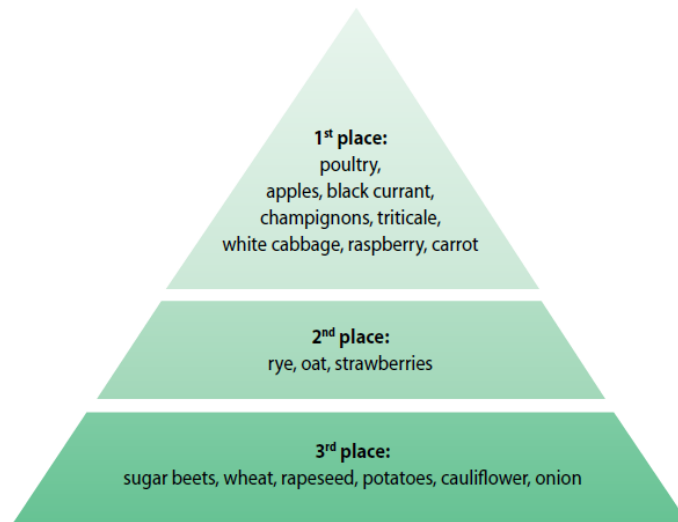


Figure 1. The dominating types of bio-industries and agriculture in the Polish South Baltic Area<sup>18</sup>

The average agricultural farm size in Poland is ca. 10,5 ha. The voivodeships (provinces) that belong to the South Baltic Sea Area have much more agriculture land than the average. West Pomeranian farms are ca. 30,3 ha, Warmia and Mazury farms are 22,9 ha and these are respectively the first and second biggest farm sizes in Poland. The Pomeranian farms are ca 19 ha, which puts them into 4<sup>th</sup> place. Fig. 2 shows the mean sizes of agriculture lands in every voivodeship.

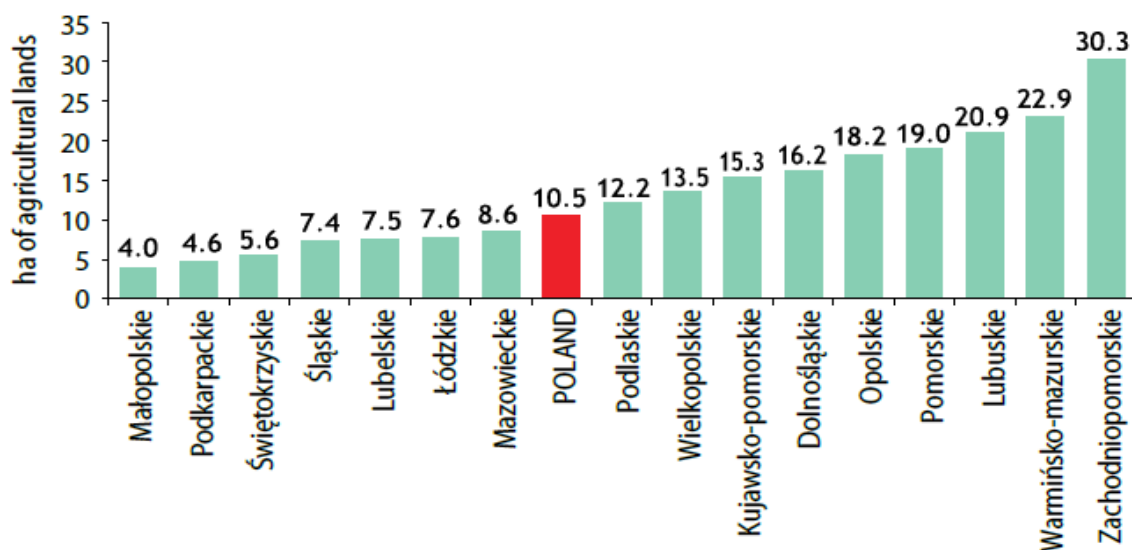


Figure 2. Mean size of agriculture lands in Poland<sup>19</sup>

As can be seen in Table 3, the total production of meat in three Polish SBA regions are very different. Most of the meat produced is pig and poultry. The proportion of every kind of meat is strongly diverse in every region.

<sup>18</sup> EUROSTAT data

<sup>19</sup> Study of the IERiGŻ-PIB, data from ARiRM

Table 3. Production of animals for slaughter

Kind	Pomerania <sup>20</sup>	West Pomerania <sup>21</sup>	Warmia and Mazury <sup>22</sup>
Total, tons	378.600	226.800	403.700
Cattle (excluding calves), tons	29.000	10.200	46.200
Calves, tons	200	300	800
Pigs, tons	215.600	50.400	118.800
Sheep, tons	200	100	100
Horses, tons	0	100	200
Poultry, tons	133.600	165.700	237.600
Goats and Rabbits, tons	0	0	0

The proportion of the forest area in the Pomeranian Region is 665.810 ha with coniferous trees being the dominant species, accounting for approximately 78,6% of the forest area. Forests cover 36,4% of the total land area in the region, which is higher than the national average of 29,4% (9.197.900 ha).<sup>23</sup>

The proportion of forest area in the Warmia and Mazury Region is 773.692 ha with coniferous trees being the dominant species, accounting for approximately 60,7% of the forest area. Forests covers 31% of the total land area in the region, which is close to the national average of 29,4% (9.197.900 ha).<sup>23</sup>

The proportion of forest area in the West Pomeranian Region is 837.561 ha with coniferous trees being the dominant species, accounting for approximately 66,7% of the forest area. Forests covers 35,5% of the total land area in the region, which is higher than the national average of 29,4% (9.197.900 ha).<sup>23</sup>

Poland is among the countries with the largest proportion of forest area in the region, following France, Germany and Ukraine.

Table 4. Removals in forest industry

	West Pomeranian <sup>23</sup> dam <sup>3</sup>	Pomeranian <sup>23</sup> dam <sup>3</sup>	Warmia and Mazury <sup>23</sup> dam <sup>3</sup>
Coniferous timber	3.197,4	2.549	2.642
Non-coniferous timber	1.178	643	1.077,8
Slash for industrial uses	65,5	25	2,5
Slash for fuel	212,6	159	135
Total	4.653,5	3.376	3.857,3
<b>Total Poland 2015</b>	<b>40.247</b>		

<sup>20</sup> Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

<sup>21</sup> Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

<sup>22</sup> Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

<sup>23</sup> Forests in Poland 2015



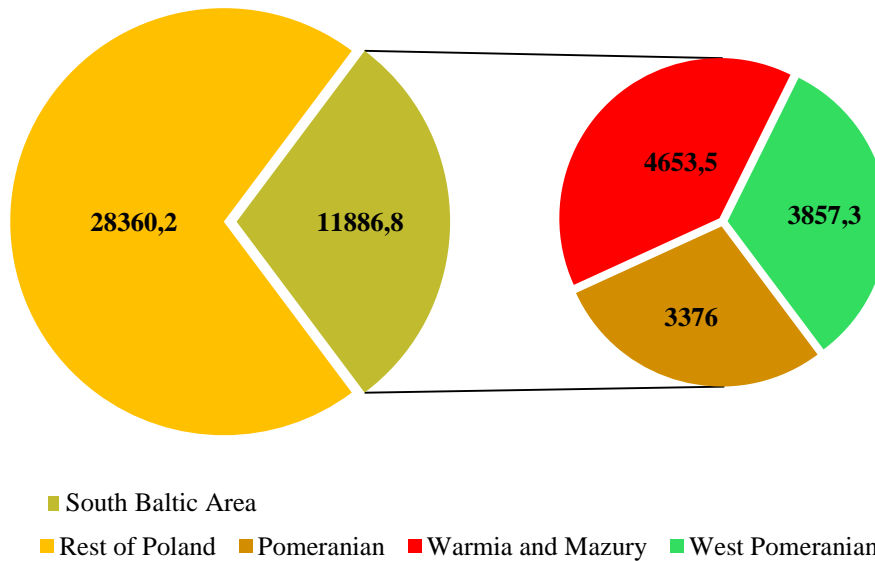


Figure 3. Total wood removals in Poland (dm<sup>3</sup>)

The statistical data from 2015 shows that employment in the Pomeranian region was encompassed 798.217 people. Agriculture, forestry and fishing industries employed 66.982 people which is about 8,4% of the total employment in the Pomeranian region. After 2015 there were still 12 vacancies in these industries while 545 jobs had been newly created. The average monthly salary in the Pomeranian region in agriculture, forestry and fishing industries was 4.369,51 PLN while the average monthly salary in Poland was 3.900 PLN.<sup>24</sup>

The same statistical data for the Warmia and Mazury region indicates that 433.237 people were employed in 2015. Agriculture, forestry and fishing industries employed 70,442 people which is about 16,3% of the total employment in the Warmia and Mazury region. After 2015 there were still 11 vacancies in these industries while 370 jobs had been newly created. The average monthly salary in the Warmia and Mazury region in agriculture, forestry and fishing industries was 4.396,52 PLN.<sup>25</sup>

The statistical data for the last Polish region in the South Baltic Area, namely the West Pomeranian voivodeship shows that 525.662 people were employed in 2015. Agriculture, forestry and fishing industries employed 50.507 people which is about 9,6% of total employment in the West Pomeranian region. After 2015 there were still 15 vacancies in these industries while 831 jobs had been newly created. The average monthly salary in West Pomeranian region in agriculture, forestry and fishing industries was 4.258,06 PLN<sup>26</sup>.

At the moment, it is not possible to indicate the shares of sustainable bioeconomy in the local economies as there are no reports available on that topic. The weakness linked to above are, among others:

1. The functioning of agriculture depends on soil conditions. Good and very good soils constitute 28,6% of all arable land, average soils – 39,1%, and poor and very poor soils –

<sup>24</sup> Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

<sup>25</sup> Statistical Yearbook Warminsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

<sup>26</sup> Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

32,3%. About 80% of soils on cultivated land in Poland are characterised by a certain degree of acidity, whereas the remaining 20% of soils have a neutral or alkaline PH. Since the majority of arable crops require mildly acidic to neutral soils in order to grow properly, the experts advise the introduction of the so-called liming procedure.

2. The value of Poland's resource productivity (measured in purchasing power standards [PPS] per kg) is one of the lowest in the EU. Improving resource productivity and ensuring sustainable resource and materials management, building on the principle of the 3Rs (reduce, reuse, recycle), is a central element of green growth policies.

The strengths linked to above are among others:

1. Poland's biodiversity is among the richest in Europe. Its transitional climate which is influenced by oceanic and continental air masses, favourable geographical position at the centre of the continent with no natural barriers to the east or the west, varied geological structure, and land and hydrographic make-up and soil types make it a good habitat for many plant and animal species. The richness of biological diversity in the country is due to many variables resulting from location and topography, soil conditions, climate impact, the level of social and economic development and historical conditions.
2. Maintaining extensive agriculture in Poland has resulted in the preservation of many local breeds of farm animals and old varieties of cultivated plants.
3. Despite the unfavourable agrarian structure and a worse, compared to other EU member states, quality of agricultural production space, Poland is a major global and European agricultural, horticultural and animal producer, with a significant workforce.

### Challenges:

Despite the fact that Polish SBA regions have weaker average soil than other regions in the South Baltic Area, better resource productivity can be obtained thanks to increasing agricultural efficiency.

### Opportunities:

Poland's genetic resources are one of the highest in the EU. It could be used to keep biodiversity in the South Baltic Area. A mapping of bioeconomy leading enterprises in the region in different sector has been accomplished. Data is presented in Table 5. The list is not complete but gives an overview of the different types of enterprise that can be found within the bioeconomy sector in the region.

Table 5. Employment in bioeconomy sector in Polish SBA

<b>Company</b>	<b>Location</b>	<b>Sector</b>	<b>Production type</b>	<b>Employees</b>
Zakłady Farmaceutyczne Polpharma S A	Koteże ( <i>Pomerania</i> )	Pharma industry	Medicine	2.146
Grupa Azoty Zakłady Chemiczne Police S A	Police ( <i>West Pomerania</i> )	Ingredients industry	production of fertilizers + plastic products	2.343
Warmińskie Zakłady Przetwórstwa Owocowo-Warzywnego Sp. z o.o.	Kwidzyn ( <i>Pomerania</i> )	Food industry	Fruits / vegetables	300
Przetwórstwo Warzyw S.C. ( <i>products with name „Lutkiewicz”</i> )	Gdańsk ( <i>Pomerania</i> )	Food industry	Fruits / vegetables	46

Goodvalley Polska	Przechlewo (Pomerania)	Food industry	Meat products	600
Animex Foods Sp z o.o. Spółka Komandytowa	Morliny (Warmia & Mazury)	Food industry	Meat products	1.100
Indykpol S.A	Olsztyn (Warmia & Mazury)	Food industry	Meat from poultry	
Destylarnia Sobieski S A	Starogard Gdański (Pomerania)	Distillery	rectification of alcohols	310
Destylarnie Warmińskie Sp. z o.o. (company registered in Warsaw)	Nidzica (Warmia & Mazury)	Distillery	rectification of alcohols	50
Browar Kormoran Sp. z o.o.	Olsztyn (Warmia & Mazury)	Brewery	beer production	20
Browar Amber Sp z o.o. Spółka Komandytowa	Bielkówek (Pomerania)	Brewery	beer production	62
Browar Gościszewo S C Stanisław Czarnecki Chrystian Czarnecki	Gościszewo (Pomerania)	Brewery	beer production	13
Bytów Browar Kaszubski Sp z o.o.	Bytów (Pomerania)	Brewery	beer production	10
Bioen Sp z o.o. (in bankruptcy)	Szczyrkowice (Pomerania)	Pellet industry	straw products	1
SYLVA Sp. z o.o.	Wiele (Pomerania)	Wood manufacturing	pellets based on wood waste	245
Ekopal Sp z o.o.	Jagodne (Warmia & Mazury)	Pellet industry	pellets based on wood waste	35
Eko Pelet Danuta Kaczkan	Klonowy Dwór (Warmia & Mazury)	Pellet industry	pellets based on wood waste	1
Poltarex Polskie Drewno sp. z o.o. (company registered in Warsaw)	Szczytno (Warmia & Mazury)	Pellet industry	pellets based on wood waste	8
Krajowa Spółka Cukrowa S A Oddział Malbork	Malbork (Pomerania)	Sugar industry	sugar	140 +100 (seasonal work)
Krajowa Spółka Cukrowa S A Oddział Kluczewo	Stargard (West Pomerania)	Sugar industry	sugar	
Przedsiębiorstwo Przemysłu Ziemniaczanego Nowamyl S A	Łobez (West Pomerania)	Potato industry	starches and starch products	120

## Biomass potentials in Polish regions of South Baltic Area

The amount of straw produced annually varies from year to year, depending on the weather and other factors. In 2015 in the Pomeranian Region 1.515.040,89 tons of straw was produced while only 1.350 161,9 tons was produced in 2010. The opposite situation can be observed in the Warmia and Mazury Region, where 1.293.685,76 tons of straw was produced in 2015 while 1.466.061,88 tons in 2010. In the West Pomeranian Region the production of straw over the years 2010-2015 was very similar, i.e. ranging from 1.798.374,37 tons in 2010 to 1.758.208,99 tons in 2015. The total straw potential in the Polish South Baltic Area is similar over the years 2010-2015, i.e. over 450.000 tons.

The production of straw from basic cereals in Poland 2016 was at the level of 20.463.000 tons. This is a huge amount that is used in a measure. The manufacture of products of wood, cork, straw and wicker in Poland gives 38.491.000.000 PLN.<sup>27</sup>

Table 6. Straw potential in Polish South Baltic Area<sup>28 29 30 31</sup>

	West Pomerania		Pomerania		Warmia and Mazury	
	Grain [tons]	Straw [tons]	Grain [tons]	Straw [tons]	Grain [tons]	Straw [tons]
<b>2010</b>						
Wheat	908.210	826.471.1	645.667	587.556,97	703 792.4	640.451,08
Rye	233.487	336.221.28	162.320	233.740,8	137 744.4	198.351,93
Barley	257.661	221.588.46	158.609	136.403,74	200 571.8	172.491,74
Oats	133.714	144.411.12	103.687	111.981,96	78 323.1	84.588,94
Triticale	238.657	269.682.41	248.211	280.478,43	327 591.3	370.178,16
<b>Total</b>	<b>1.771.729</b>	<b>1.798.374,37</b>	<b>1.318.494</b>	<b>1.350.161,9</b>	<b>1.448.023</b>	<b>1.466.061,88</b>
<b>2014</b>						
Wheat	899.702	818.728,82	868.115	789.984,65	699.982,2	636.983,80
Rye	248.749	358.198,56	173.132	249.310,08	91.337,2	131.525,56
Barley	232.623	200.055,78	139.967	120.371,62	120.541,2	103.665,43
Oats	74.527	80.489,16	88.746	95.845,68	72.396,2	78.187,89
Triticale	264.500	298.885	260.233	294.063,29	340.655,8	384.941,05
<b>Total</b>	<b>1.720.101</b>	<b>1.756.357,32</b>	<b>1.530.193</b>	<b>1.549.575,32</b>	<b>1.324.912,6</b>	<b>1.335.303,75</b>
<b>2015</b>						
Wheat	943.030	858.157,3	850.744	774.177,04	741.110,7	674.410,73
Rye	211.275	304.236	158.452	228.170,88	79.201,9	114.050,73
Barley	210.713	181.213,18	120.702	103.803,72	100.919,5	86.790,77
Oats	71.012	76.692,96	74.718	80.695,44	52.241	56.420,28
Triticale	299.035	337.909,55	290.437	328.193,81	320.365,7	362.013,24
<b>Total</b>	<b>1.735.065</b>	<b>1.758.208,99</b>	<b>1.495.053</b>	<b>1.515.040,89</b>	<b>1.293.838,8</b>	<b>1.293.685,76</b>

<sup>27</sup> Concise statistical yearbook of Poland

<sup>28</sup> Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

<sup>29</sup> Statistical Yearbook Warminsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

<sup>30</sup> Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

<sup>31</sup> Straw balance in Poland in the years 2010-2014 and forecast to the year 2030, A. Madej, Stowarzyszenie Ekonomistów Rolnictwa i Agrobiznesu

Table 7. Straw applications in Polish SBA in 2015 (tons)<sup>32 33 34</sup>

	<b>Pomerania</b>	<b>West Pomerania</b>	<b>Warmia and Mazury</b>
Total amount of straw	1.515.040,89	1.758.208,99	1.293.685,76
Feed	174.835,72	291.862,69	287.974,5
Bedding	342.247,74	407.904,49	341.145
<b>Potential</b>	<b>997.957,43</b>	<b>1.076.023,9</b>	<b>664.566,4</b>

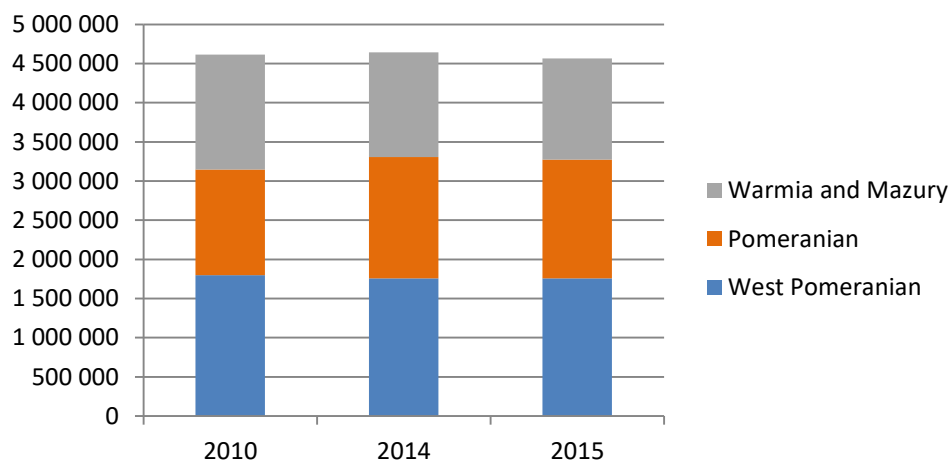


Figure 4. Total straw potential in Polish SBA

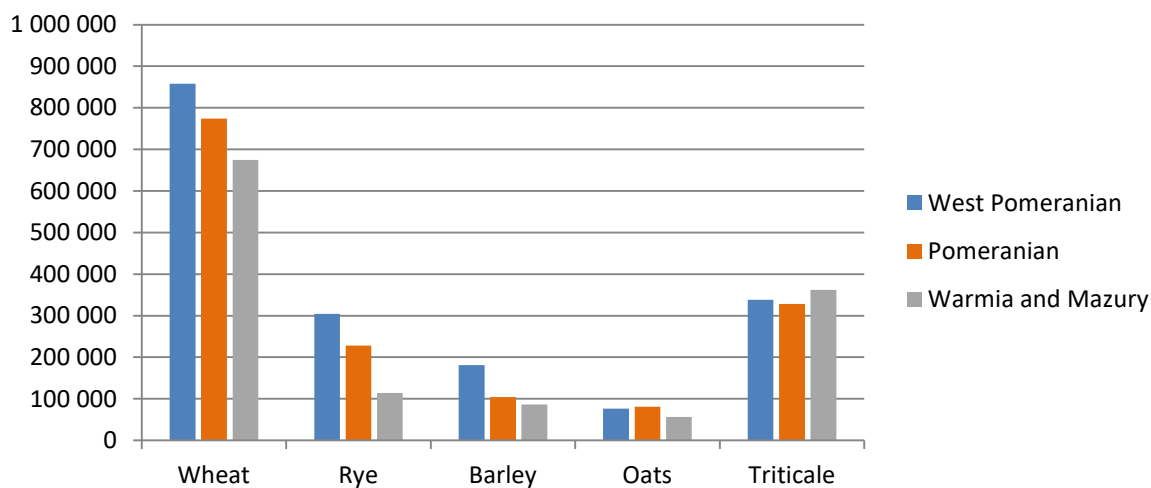


Figure 5. Kinds of straw in Polish SBA in 2015

<sup>32</sup> Ability to use straw as local fuel, W. Gostomczyk, Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, 2017

<sup>33</sup> Development of straw and the possibilities of its use for the production of formable fuels on the example of the Warmian-Masurian Voivodeship, R. Bał, Inżynieria Rolnicza 1(99)/2008

<sup>34</sup> Possibilities of using straw for energy purposes in the Pomeranian Voivodeship, K. Gafka, D. Janiszewska, Zeszyty Naukowe Wydziału Nauk Ekonomicznych, 07.02.2017

The main utilization for the straw produced in the Polish South Baltic Area is agriculture applications (a huge amount of straw is left in the fields). There are only a few companies which use straw as a source of energy (e.g. Bioen close to Lębork).

Table 8. Sugar production in 2017 in Malbork sugar factory

	Amount [tons]	Present use	Location
Sugar beets input	729.933		Malbork
Soil	131.388		Malbork
Cossettes	569.347		Malbork
<b>Product</b>			
Sugar	81.035		Malbork
<b>By-products</b>			
Molasse	19.622	Feed	Malbork
Beet Pulp (fresh pulp, pressed pulp, dried pulp)	483.944	Pulp	Malbork
Carbonation Lime (CaCO <sub>3</sub> , Nutrins)	49.106	Unknown	Malbork
<b>Total by-products</b>	552.672		

The National Sugar Company (Krajowa Spółka Cukrowa) has two sugar factories in the Polish South Baltic Area, one in the Pomeranian Region (Malbork) and one in the West Pomerania Region (Kluczewo). The sugar factory in Malbork utilised 481.000 tons of sugar beets in 2015 to produce around 53.400 tons of sugar.

The sugar factory in Kluczewo utilised 548.000 tons of sugar beets in 2015 to produce around 60.800 tons of sugar. This amount can vary over the years. For example, the sugar factory in Malbork produced around 81.000 tons of sugar from around 730.000 tons of sugar beets in 2017. Hence one ton of beets amount to 111 kg of sugar, 26 kg of molasses, and 663 kg of beet pulp. There are individual waste management plans for every region in the Polish SBA. Based on these documents analyses were done.<sup>35 36 37</sup>

<sup>35</sup> Plan gospodarki odpadami dla Województwa Pomorskiego 2022

<sup>36</sup> Plan gospodarki odpadami dla Województwa Warmińsko-Mazurskiego 2016-2022

<sup>37</sup> Plan gospodarki odpadami dla Województwa Zachodniopomorskiego 2016-2022 z uwzględnieniem perspektywy na lata 2023-2028

## The Pomeranian Region

Table 9. The morphological composition of municipal waste divided into big cities, small towns and rural areas.

N.	Kind of waste	Large city (>50 k. People)	Small city (<50 k. people)	Villages
1	Paper and texture	19,1	9,7	5,00
2	Glass	10,00	10,20	10,00
3	Metals	2,6	1,5	2,4
4	Plastics	15,1	11,00	10,30
5	Multi-material waste	2,50	4,00	4,10
6	Organic waste	34,20	42,00	35,60
7	Other wastes	13,90	19,00	31,30
7.1	Mineral wastes	3,20	2,80	6,00
7.2	Fraction <10 mm	4,20	6,80	16,90
7.3	Fabrics	2,30	4,00	2,10
7.4	Wood	0,20	0,30	0,70
7.5	Dangerous	0,80	0,60	0,80
7.6	Others	3,20	4,50	4,80
8	Bulky waste	2,60	2,60	1,30

Table 10. The morphological of organic wastes in Pomerania Region

No.	Kind of waste	Mass of wastes [tons]
1	Paper and texture	13.501,1
2	Biomass wastes	72.554,4
3	Clothing and textiles from natural fibers	349,3
4	Wood	36,2

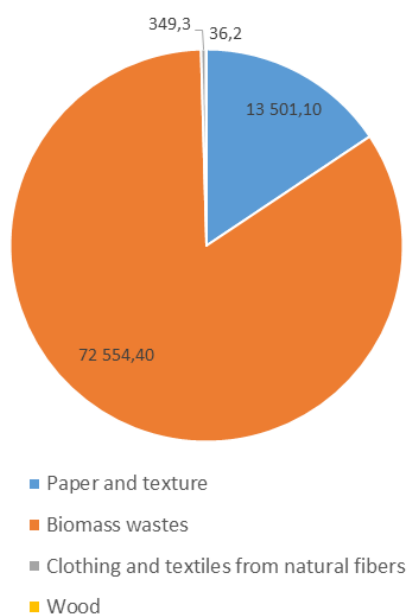


Figure 6. Organic wastes in Pomerania Region [tons]

## The Warmia and Mazury Region

Table 11. The morphological composition of municipal waste

N.	Kind of waste	Percentage
1	Paper and texture	14,6
2	Glass	8,6
3	Metals	2,0
4	Plastics	14,1
5	Bulky waste	3,6
6	Fraction <10 mm	9,6
7	Fraction 10-20 mm	8,1
8	Textiles	3,9
9	Wood	0,6
10	Dangerous	0,02
11	Inert waste	3,3
12	Electric and electronic	0,27
13	Batteries	0,01
14	Other wastes	5,9
15	Organic wastes	25,4

Table 12. The morphological of organic wastes in Warmia and Mazury Region

N.	Kind of waste	Mass of wastes [tons]
1	Paper and texture	3.466,21
2	Biomass wastes	14.064,12
3	Clothing and textiles from natural fibers	7,7
4	Wood	0,5

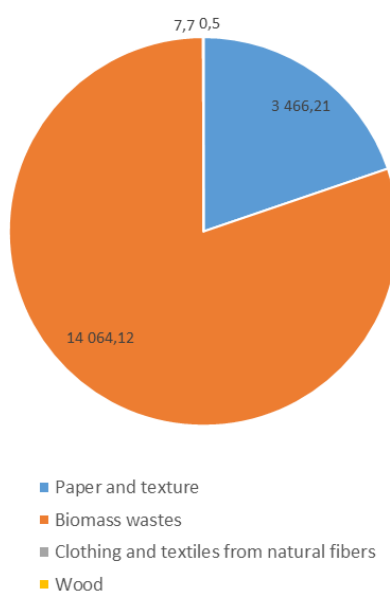


Figure 7. Organic wastes in Warmia and Mazury Region [tons]



## West Pomeranian Region

Table 13. The morphological composition of municipal waste

No.	Kind of waste	Mass [tons]
1	Paper and texture	1.018,2
2	Glass	774,4
3	Metals	1,1
4	Plastics	108,6
5	Bulky waste	11.300,4
6	Other fractions	3.707,0
7	Textiles	21,5
9	Wood	589,4
10	Electric and electronic	875,73
11	Batteries	10,5
12	Other wastes	414.217,4
13	Organic wastes	25.643,8

Table 14. The morphological of organic wastes in West Pomeranian Region

N.	Kind of waste	Mass of wastes [tons]
1	Paper and texture	1.018,2
2	Biomass wastes	25.643,8
3	Clothing and textiles from natural fibers	21,4
4	Wood	589,4

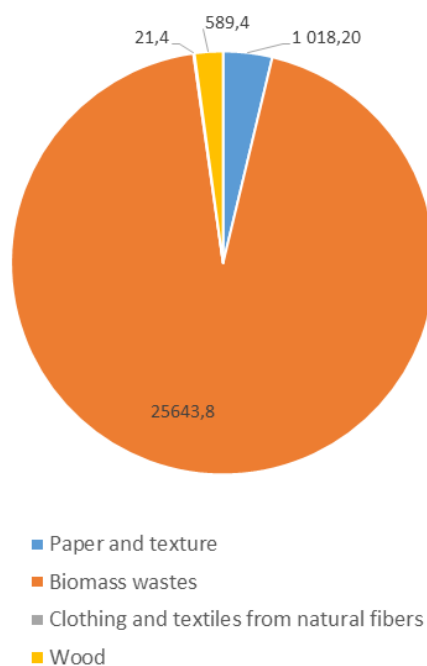


Figure 8. Organic wastes West Pomerania Region [tons]

## Biomass opportunities in Polish regions of the South Baltic Area

The biorefining and agri-food industries are the noticeable sectors within the bioeconomy in the regions today. Future opportunities for innovation and development within the bioeconomy is also found in relation to these sectors. We have here selected a few areas with promising business opportunities that could be interesting for enterprises in the Pomeranian Region.

### Biogas production

In 2011–2014, the amount of agricultural biogas produced in Poland increased by 137,29 million m<sup>3</sup> from the level of 36,65 million m<sup>3</sup> in 2011. In the analysed years, the amount of electricity and heat generated from agricultural biogas increased by 281,48 GWh and 291,06 GWh respectively. The table below presents data on the production of biogas, electricity and heat produced from agricultural biogas in Poland in the years 2011–2014.<sup>38</sup>

Table 15. Biogas potential over the years in Poland <sup>38</sup>

Year of production	Amount of produced agriculture biogas [Mm <sup>3</sup> ]	Amount of electricity produced from agriculture biogas [GWh]	Amount of heat produced from agriculture biogas [GWh]
2011	36.646	73.433	82.638
2012	73.152	141.804	160.128
2013	112.412	227.880	246.557
2014	173.932	354.916	373.695

This is not much in terms of the potential of the agricultural biogas economy in Poland. The theoretical potential is 5 billion m<sup>3</sup> of biogas per year, while the real potential is approx. 1,7 billion m<sup>3</sup> of biogas per year. The development of the agricultural bio-power sector can become a stimulator for the development of agriculture and agribusiness in Poland in the coming decade. The real economic potential of agricultural biogas in Poland by 2020 is presented in the table below. The plants located in the Pomeranian province have the highest annual capacity for agricultural biogas production (a total capacity of 38.060.655 m<sup>3</sup>/year, i.e. 15,6% of the overall capacity in Poland). Also, the plants located in Warmia and Mazury, and West Pomerania have relatively high total capacities for agricultural biogas production (exceeding 20.000.000 m<sup>3</sup>/year).<sup>39</sup>

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<sup>38</sup> Arkadiusz Piwowar, Maciej Dzikuć, Janusz Adamczyk, Agricultural biogas plants in Poland – selected technological, market and environmental aspects, *Renewable and Sustainable Energy Reviews* 58 (2016) 69–74

<sup>39</sup> The real economic potential of agricultural biogas in Poland by Wiśniewski G, editor. *Ekspertyza dla Ministerstwa Gospodarki*. Warszawa: Instytut Energii Odnawialnej; 2007.

Table 16. Biogas production potential according to type of substrate<sup>39</sup>

Year of production	Real technical potential [TJ]	Real economic potential–final energy [TJ]	Market potential 2020 [TJ]
Biomass, including:	929.564	600.167	600.167
Agricultural wastes	178.422	123.066	123.066
Energy crops, including:	479.167	286.719	286.719
Maize silages	116.626	81.638	81.638

Pre-treatment technologies for agro-food waste and crop residues are already being tested today. Further implementation will make it possible to utilise new type of biomass as feedstock and enhance biogas yields in planned and existing biogas plants. The region has substantial amounts of unutilised crops residues (e.g. straw) and other types of agro-food waste that is today mainly used for soil-improvement (e.g. mash and sugar beet tops).

### Biorefining of ingredients for food products

Biorefining of high-value food ingredients from residuals from the regional food industry also offers promising business opportunities for enterprises in the region. Today, a high-value product with huge amounts of sugar is already being produced in the Sugar Factory in Malbork. Moreover, the food waste can be utilized as a substrate in the process of alcohol production. There is one distillery with its own biogas plant in Melno (close to the south border of the Pomeranian Region, ca. 50 km to Malbork), which uses bakery waste, other organic waste and beet pulp to produce alcohol. There is an opportunity for cooperation with Sugar Factories in Malbork, Distilleries in Melno, Fruit Processing Plants in Kwidzyn and Slaughterhouses Goodvalley (former Poldanor S.A). Also, waste from a few local breweries (Bytów Browar Kaszubski) has interesting potential.

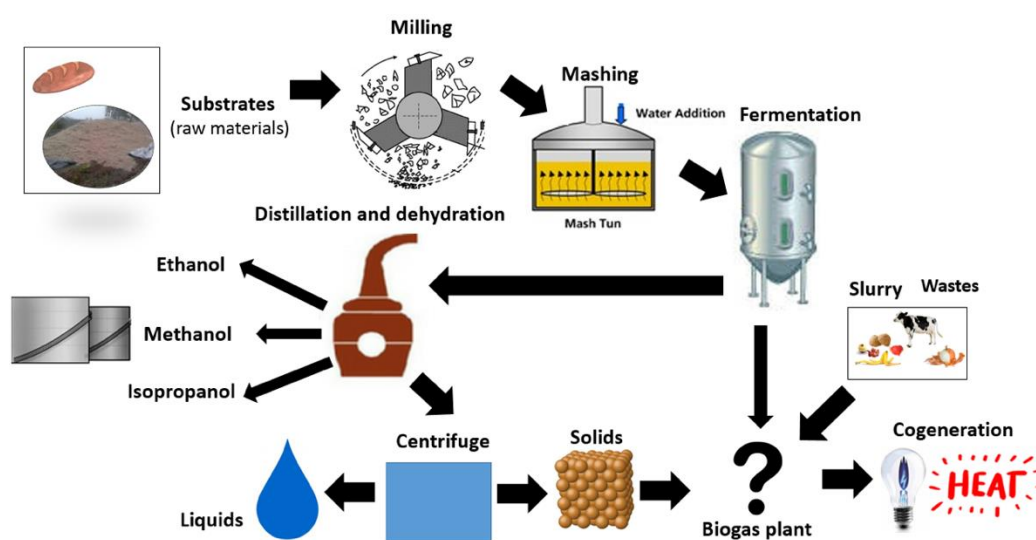


Figure 9. Bioeconomy cycle in Melno distillery and biogas plant

## Straw-bale building in Poland<sup>40</sup>

One possible way towards more sustainable architecture is a combination of consciously simple building technologies, raw and naturally grown materials, the use of hands-on human labour and learning from traditional and vernacular building methods. Such a set of characteristics can be described as low-tech architecture. It can be seen as an architectural implementation of the idea of 'appropriate technology' defined by E.F. Schumacher. Straw-bale is one of building technologies which follows the principles mentioned above. Because of its many advantages, especially high isolation value, it has a growing number of dedicated enthusiasts in the USA and in many European countries, including (in the last decade) Poland. No longer is straw-bale just an experiment, it has developed to be a viable alternative to conventional construction technologies. Official tests and following building regulations carried out in many countries are a proof of this transition. In the year 2000 construction of the first straw-bale house started in Poland. In 2011 there were more than 30 buildings that were either finished or in construction. Research carried out by the author, shows that straw-bale building is currently in a stage of rapid development and professionalization of workmanship. As a result, it is likely to play an important role in the future of sustainable building in Poland.



Figure 10. Prototype of open-source house 'Nano-habitat' during a) wall construction, b) plastering.  
Photo courtesy of Paweł Sroczyński <sup>40</sup>

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<sup>40</sup> Strawbale Building in Poland, M. Jagielak [source:  
[http://osbn.pl/sites/default/files/pliki/Strawbale%20building%20in%20Poland\\_Maciej%20Jagielak\\_0.pdf](http://osbn.pl/sites/default/files/pliki/Strawbale%20building%20in%20Poland_Maciej%20Jagielak_0.pdf)]