Assessment of the Potential and Use of Renewable Energy Sources in the Municipality of Września

Weronika Bojarska, Jacek Leśny and Monika Panfil

Abstract The following work presents the analysis of the potential of renewable energy sources in Września Municipality. Moreover, it gives an insight into the extent of their use and indicates some possibilities of their further development. The conducted analyses stipulate that this area has a great potential in terms of wind and biomass energy. As far as the former is concerned, the existing administrative limitations to all intents and purposes make it impossible to develop a high capacity wind power plant, whereas in the case of latter the barrier stems from inhabitants' fear of the possible nuisance of biogas plants to be established. There is a great geothermal potential in the area where Września Municipality is located, however tapping into it would require more detailed research. It is useful that the city of Września has an extensive heating network, which would facilitate heat distribution coming from a geothermal facility. The remaining renewable energy sources such as solar batteries, photovoltaic cells, heat pumps and small windmills will probably be developed exclusively depending on individual entrepreneurship and financial resources of inhabitants.

Keywords Renewable energy sources · Potential · Use · Municipality

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1 Introduction

Reconciling the pace of economic development, which entails increased energy demand, with the obligation to prevent climate changes is considered one of the biggest problems of civilization. This issue is becoming increasingly important in the international politics. The European Union undertakes activities supporting enforcement of the Kyoto Protocol provisions in terms of the development of energy production from alternative energy sources [1, 7, 8]. The energy sector in Poland faces a huge challenge caused by decreasing coal resources, dependence on external supplies of resources and their price fluctuations, and also fulfilling the EU commitments [19]. According to the adopted energy package, i.e. 3 × 20%, Poland must increase the share of the energy coming from RES in the total energy consumption to 15% gross until 2020 [18]. It should be expected that the targets of the EU climate policy will tend to aim at further increase in RES use in the energy consumption in the following years [25, 28].

Rational use of particular energy sources constitutes one of the key components of sustainable development which will contribute to improving the condition of the environment, will lead to savings and more effective application of energy resources. Therefore, these energy sources are expected to be developed in the nearest future [20].

According to Danuta Huebner, an ex-European Commissioner for Regional Policy, local governments can play an important role in the development of energy from renewable sources because more and more investments are conducted both on the local and regional level. Moreover, local governments should insist on improving the condition of natural environment by decreasing emitted pollution and increasing energy safety in municipalities [31].

Currently Poland is divided into 2478 municipalities 3. One of them is the urban and rural Września Municipality [3]. As far as demography is concerned this municipality is considered to represent "Poland in a nutshell", hence primary elections, both presidential and parliamentary, were often held here. Therefore, it has been assumed to be a good example of a municipality to be analysed in terms of its potential and development of renewable energy sources, because this development cannot take place without support and participation from the local community.

2 Characteristics of Września Municipality

The surface of the municipality is 222 km^2, 13 km^2 of which are occupied by the city of Września (6% of the total municipality area), and countryside takes up 209 km^2, which constitutes as much as 94% of the total surface area. In 2015 the municipality was inhabited by 45 952 people, 65% of whom lived in urban areas and 35% in rural areas.

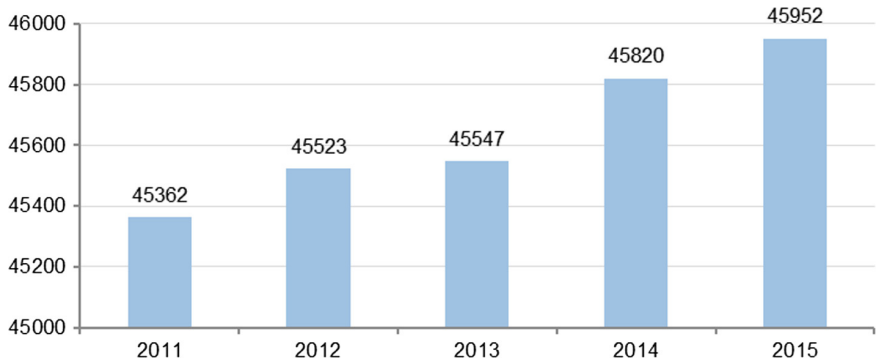

Fig. 1 Fluctuations in the population numbers of Września Municipality in 2011–2015 [5]

Września Municipality is an attractive place for settlement and building own house, which leads to the increase in the population numbers (see Fig. 1) [27]. The population of the municipality is also an important factor influencing its development and energy consumption [14].

According to the data from the Main Statistical Office [5], 15 995 flats were registered at the end of 2015 in Września Municipality, 11 350 of which in the city and 4 645 in rural areas. Their number is continually growing. It is predicted that by 2020 the number of flats will have increased up to nearly 17 000. This rise is connected with the population growth in the municipality. Every year 216 new flats on average appear here [15].

Thanks to a very good location near the main railway and motorway connecting Poznań with Warszawa, business activity in the municipality is steadily developing. According to the company registration numbers' list, at the end of 2015 there were 5 695 economic entities registered in the municipality. The increase in the number of inhabitants, flats and economic development are the factors which entail growing demand on electrical energy. Table 1 presents energy consumption in 2010 and 2015 as well as the forecast for 2020 and 2030.

Also the demand on heat energy is growing together with the need for electrical energy. W Table 2 presents the demand on energy needed to heat up the buildings in 2010, 2015, and also the forecast for 2020 and 2031.

Table 1 Calculations of the electrical energy demand for buildings in Września Municipality until 2031 r. [14]

Balance of electricity demand	j.m.	2010	2015	2020	2031
Residential buildings	kWh	26 189 280	27 846 928	29 490 208	32 517 280
Public utility buildings	kWh	2 946 285	3 196 336	3 377 976	3 706 976
Industrial buildings	kWh	126 035 910	130 032 760	133 711 550	137 792 200
Total	**kWh**	**155 171 475**	**161 076 024**	**166 579 734**	**174 016 456**

Table 2 Calculations of the heat energy demand for buildings in Września Municipality until 2031 [14]

Balance of heat demand	j.m.	2010	2015	2020	2031
Residential buildings	kWh	196 419 600	199 771 440	201 069 600	203 233 000
Public utility buildings	kWh	11 130 410	11 259 820	11 259 920	11 706 240
Industrial buildings	kWh	44 194 410	45 402 500	46 246 100	47 556 600
Total	**kWh**	**251 744 420**	**256 433 760**	**258 575 620**	**262 495 840**

In rural areas of the municipality the heat energy is produced by using individual boiler rooms in households, whereas in the city heat energy is produced and distributed by Veolia Energia Poznań S.A, Facility East Września District, which uses heat networks. The total length of the heat network in the studied municipality is 26 245 lm. The biggest recipient of the heat energy provided by the above mentioned company is Września Housing Cooperative, which consumes almost 56% of the total heat energy produced. The second largest recipients are housing cooperatives in the city of Września, which use 18.2% of the heat energy, next are offices and institutions (8.5%) (see Fig. 2).

In the buildings which have individual boiling rooms the prevailing fuels used are as follows: coal, coke, coal dust and wood. Additionally, heating oil or natural

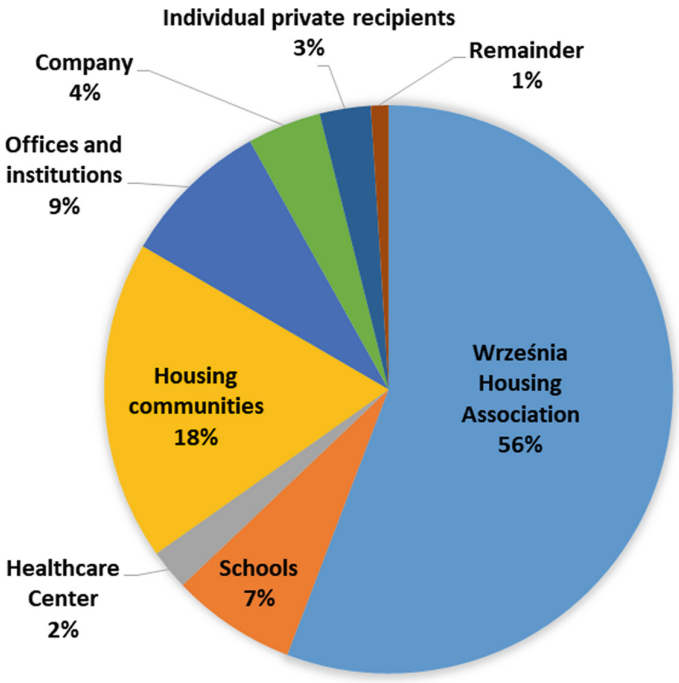

Fig. 2 The structure of heat energy recipients in the municipality [14]

gas are used for that purpose to a limited extent, the latter mostly in newly built houses. Unfortunately this leads to a huge increase of the so called low emission and negatively impacts air quality.

3 The Potential and Use of Renewable Energy Sources

3.1 Solar Energy

Both the studied municipality and the whole Poland, due to its location in the middle latitude, do not belong to the privileged areas in terms of the possible application of solar energy. Solar conditions in Poland are characterized by low variation and the analyzed area does not differ from the rest of the country in this respect [6, 30]. In the studied area, with an optimum setting of the surface absorbing sun rays one can obtain about 1.15 kWh/m^2 of heat energy annually, while it is best to use this type of energy in the summer, whereas in another season it is good to meet energy demands by combining solar power with other energy sources [12, 13, 16]. It should be emphasized that installation of such facilities is quite expensive, therefore few people decide to use this technology without any financial support [14]. In comparison to previous years a significant increase in energy production from photovoltaic facilities has been observed. Technological progress can lead to a situation when the conditions of their development will soon become different, i.e. if the efficiency of photovoltaic cells increases, their price will drop [30].

Households in the municipality derive energy both from solar collectors installed on the buildings as well as from photovoltaic panels. However, no record of these facilities is kept [27]. Despite the fact there is a certain potential of this type of energy production, it is not predicted that the installed solar collectors might be developed here into any compact systems in the future. However, it is envisaged that in the following years the market of solar collectors will be still developing at a medium pace in a linear manner. So far the growth has been occurring without any substantial support of the state [30].

An example of an activity connected with obtaining energy from renewable sources is installing solar collectors on the building of the dormitory belonging to the School Complex and hospital (District Office) and also installing photovoltaic panels on the renovated building which will be occupied by the Special schools Complex and the Psychological and Pedagogical Counseling Centre.

Table 3 Wind power plants in Września Municipality

Localization	Power (MW)
Nadarzyce	0,85
Grzybowo	0,85
Kaczanowo	0,85
Kaczanowo—2 electricity	1,2

3.2 Wind Energy

The average wind velocity at the altitude of 10 m is about 3 m/s in the area of Września Municipality [2, 10, 17]. The frequency of winds which have the velocity from 4 to 9 m/s is 55% [16]. Thus, the area is quite favorable in terms of obtaining wind energy. Moreover, a big proportion of arable lands and a small proportion of protected areas indicate that Września Municipality has a great potential as regards wind energy production and use.

According to the data obtained from Września Municipality and City Office there are five wind power plants in the analyzed area, which have the combined capacity of 3.75 MW (Table 3).

Three of them with the combined total capacity of 2.55 MW are G58 type power plants from the Spanish company Gamesa. These turbines have high efficiency even by a relatively low wind velocity. The facilities are also equipped with a mechanism that limits the level of emitted noise as well as with innovative systems for controlling the functions of turbines.

Nowadays the local development plans binding for Września Municipality do not provide for accommodating wind power plants.

According to the materials obtained from the Municipality Office regarding administrative proceedings connected with wind power plants a decision was issued as to the location of a public investment facility, i.e. one wind power plant up to the height of 120 m and air blades span of up to 80 m in Otoczna. Whereas the proceedings regarding the decision about the development for foundation of one power plant of the capacity of up to 4.5 MW in Sobiesiernie were adjudicated. Also the decision regarding the development conditions for foundation of 4 turbines of 3 MW capacity each in Goniczki met with a rejection, the same as 1 turbine of 0.6 MW capacity in Sędziwojew.

So far poor development of household power plants has been observed here, which is caused by legal, economic and technical limitations [4, 30].

3.3 Geothermal Energy

Września Municipality, which is located in the area of Mogilno-Łódź Basin, belongs to Szczecin and Łódź geothermal district characterized by a substantial abundance of geothermal waters and high values of heat flux. Września Municipality lies in the area where the temperature at the depth of 2000 m is about 72–80 °C. According to research results these areas have proper conditions for developing this type of energy [26]. However, the current state of analysis of geothermal waters in the studied area is insufficient to estimate the profitability of the investment connected with a possible location of geothermal heating facilities in this area [9].

It is possible to use the geothermal energy and groundwater energy by using individual heat pumps for obtaining warm running water, water for heating buildings and air-conditioning. However, due to the lack of records of these installations in private buildings it is hard to estimate their numbers in the municipality.

3.4 Hydroelectric Power

In comparison with other regions, hydropower in Wielkopolska plays quite a small role because of the unfavorable water balance observable in this region [24]. One of the places in the municipality where hydroelectric power could be obtained is in the water basin Lipówka with the net capacity of 16.32 kW and the net potential of 143 thousand kWh [24]. It is hard to estimate the cost of constructing a hydroelectric facility and also the economic viability of such an investment.

3.5 Biomass and Biogas Energy

The analyzed area belongs to Śrem and Września agricultural and soil region [11, 17]. The analysis of land structure indicates typically agricultural character of the municipality whose area in 82% is occupied by farmland, almost 78% of which is arable land. They are dominated by a good wheat complex, which constitutes 35% of the lands. The second most common cereal is a very good rye complex, i.e. 22% of the arable land. Taking into consideration the plant production of the municipality the biggest share of crops consists of cereals. Also industrial crops, such as rape, agrimony and potatoes have a big share [16, 21–23, 29].

Due to a very big share of agricultural production and farmland in the structure of land use in Września Municipality, it can be concluded that this area has got very good conditions for using biomass for energetic purposes. The development of energy production from biomass is vital and opens new perspectives for this municipality although currently it is not a popular way of obtaining energy in the studied area. There are individual buildings with boilers using biomass but there is no record kept in terms of their numbers [16].

Taking into considerations biogas plants there are no facilities of this type in Września Municipality at the moment. However, in October 2013 a decision was issued allowing the construction of an investment known as Biomass Energy Production Facility. Currently this biogas plant is being constructed in the waste treatment plant and according to the information obtained from the manager of the plant the construction is soon supposed to be completed. The investment is conducted by a company from Poznań, i.e. Delta Power Rent. This is a mechanical and biological waste treatment plant which applies activated sludge to remove biogenic compounds. The range of the investment will involve using sewage sludge and other organic mass derived from agricultural activities as a renewable energy carrier

(the following types of mass are planned to be used: whey, cereal straw, corn silage and potato pulp, mainly from local providers). Waste and sludge will undergo methane fermentation, and biogas will be produced in the process, which will become an energy source for the biogas heat plant providing heat and electric energy for Veolia and Enea. Basic elements of the planned investment should be as follows: a biogas plant, CHP units and facility for thermal biomass conversion. The project was financed by the National Fund for Environment Protection and Water Management and the scheduled cost of the investment is 45 ml PLN. The facility in Września has been designed according to the BAT (Best Available Technology). The designed biogas plant will not emit any notorious noises and it will improve environmental conditions around the waste treatment plant by covering digester chambers which are now open and exude unpleasant smells. The construction of the biogas plant was delayed by three years because of the protest issued by the Ecological Association of Friends of the Netze District Śmiłowo against the decision concerning the facility specificities.

Additionally, in Goniczki a private investor planned on constructing an agricultural biogas plant with the capacity of 1 MW, but the project was met with public outcry because the inhabitants were afraid of the smell and nuisance connected with the biogas plant. On the other hand, in 2012 Września District Foreman gave a permission for the construction of a biogas agricultural plant with the capacity of 0.84 MW in Nowa Wieś Królewska village. Unfortunately no information has been found as to whether the investments will be implemented.

4 Discussion and Summary

The economy of Września Municipality is of industrial and agricultural character. The industry is being developed in the city and its neighbouring areas, which is caused by an attractive location of the municipality. In the past it was a typically agricultural area and industry has become a unique added value. The consequence of this structure of the municipality accounts for its high potential of biomass energy and wind energy. This stems from a high proportion of arable land with good soils in the area as well as small forest surface and few protected areas which occupy merely 2.8% of the municipality and also the location in a very favorable wind energy zone. Unfortunately at the moment only one biogas plant is being constructed and even though the permission for the second one has already been issued, it is not known whether the investment is going to be implemented. The construction of the biogas plant raises social concerns and objections. It seems that a lot of educational work needs to be done or the protesters have to change personal opinions and believe that these investments are not a nuisance for the neighbourhood.

In a sense one might say that Września Municipality was lucky that 5 wind power plants are active in its area. The current situation concerning selling energy obtained from RES, i.e. very low price of green certificates and administrative restrictions, dramatically decreases any chances of building new power plants.

Perhaps a well-developed district heating network which powers many buildings in the city opens a good perspective for Września. It means that if the construction and exploitation of geothermal drillings turned out feasible, after a detailed examination, then the heat from this source could be easily put to use and serve the inhabitants.

The remaining renewable energy sources such as solar collectors, photovoltaic cells, heat pumps and small wind mills will probably develop only depending on individual entrepreneurship and financial resources of the inhabitants.

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