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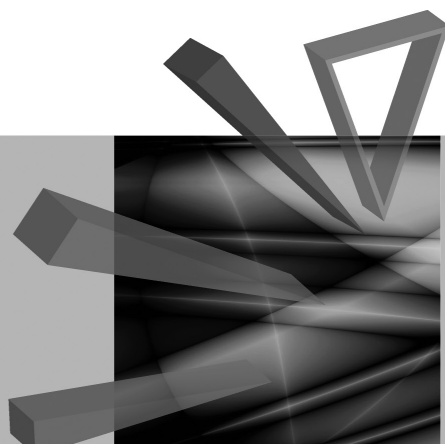
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Efektywne gospodarowanie zasobami przyrodniczymi i energią



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DEVELOPMENT OF SMALL GEOTHERMAL AND HYDROELECTRIC POWER PLANTS IN POLAND AS A CHANCE FOR ENERGETIC SECURITY AND REGIONAL GROWTH

Summary: The paper provides a short overview of the current situation and directions of development of Polish energy sector. It also considers the chances and limitations that may come from different EU regulations and focuses mainly on the possibilities of developing the extensive geothermal potential in Poland using domestic and foreign examples and experiences. A brief characteristic of the life cycle of a geothermal resource is provided as a proof for its relevance to sustainable development. There is also some potential for developing hydro plants in Poland. This process should be connected with making elaborate plans for multi-purpose projects that would benefit the region in a number of ways, not just energy. Developing those relatively expensive to build but cheaper to maintain technologies can help Poland to be more secure and independent and provide an economic boost for local communities while encouraging them to cooperate on joint projects.

Keywords: geothermal energy, hydro plants, renewable energy, sustainable development.

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1. Introduction

Polish energy sector is defined and described mostly through its high dependence on coal and other fossil fuels. Indeed, coal is the main resource in the process of energy and heat generation since it covers around 90% of the demand for energetic resources. When we think about their effective use, we should not only consider fossil fuels. The broader perspective is being developed thanks to the strong emergence of green technologies and the specific resources. However, there are some natural riches that people still have problems to view as such.

In this short paper I would like to briefly highlight the reasons why geothermal energy could prove to be a valid and effective source of both heat and power generation and why it should be given much more support. Keeping in mind the economic limitations, I will argue that small geothermal projects can make their way into the Polish landscape and satisfy the needs of local communities. Similar argument

could be made about the hydroelectric power plants, but to a much smaller degree and from different reasons. It is also worth noting that once there were thousands of water turbines operating in Poland that provided cheap energy for local use but their number has diminished since then. I will also focus on the type of geothermal resources and their potential for national energetic security, as well as on hydro plants and the general economic framework for their possible development of the Polish energy sector.

2. EU energy policy

The EU regulations and directives, such as the Energy Roadmap 2050, the EU Climate and Energy Package or the Energy Efficiency Directive, make it clear that EU is going towards a low carbon economy; that much is being stated directly. The conclusion, that some journalists and even specialists make from it, is that the immediate goal is to limit and, in the longer term, leave out coal from the energy mix of the Member States. The major goal of the Roadmap 2050 is, however, to limit CO₂ emissions, and that could also be done thanks to clean coal technologies aiding the growing sector of renewables. Such an approach would also be the only reasonable in case of countries having a more heavily fossil fuel-oriented energy sector. Poland is one of those countries and its representatives have been reiterating this point over and over at the European level.

According to the EU Climate and Energy Package from 2007, the Member States should aim at acquiring a 20% share of renewable energy sources in their energy mixes until 2020. In the recognition of its high dependence on coal in energy and heat generation, for Poland these standards have been set at 15%. Although the EU and the general public seem ready to follow the path of green and clean energy generation, let us not forget that this is not the first EU plan regarding renewable energy sources. There were other scenarios that set the goal of substantially increasing the role of renewables, but their deadlines passed without most of us really knowing about it – those were most popular only when they were issued. Such plans were also formulated in Poland long before it joined the EU and past goals for 2010 or 2012 are now the goals for 2020.

3. Polish energy sector

With the growing public and political sensitivity towards the issue of climate change and the actual increase and efforts being made to promote clean and renewable energy sources, those scenarios have a much greater chance to succeed now. It is also important to distinguish between the requirements resulting from the Energy Roadmap 2050 with its goals for low-carbon economy and the EU Climate and Energy Package. Although initially predictions were grim, it seems that already in 2010

Poland was able to reach a 9,5% share of energy generated from renewable resources which was the goal for 2014 [Graczyk 2012].

What is usually referred to and presented as a typical image connected with renewable energy sources are photovoltaic panels and wind turbines. Those have good potential to move our imagination and have the air of clean high-level technology around them. I do not plan to go deeper into the actual pollution connected with the manufacturing of solar panels that is responsible for emitting such substances like hexafluoroethane and SF₆ that are respectively 12000 and 23000 times more harmful greenhouse gases in comparison to CO₂ [Zehner 2012]. I will, on the other hand, make my point about the situation and potential for the use of the geothermal resources that Poland has in abundance. The general support given mostly for the development of technologies connected with solar and wind power generation can make the impression that other renewable energy sources are less attractive or efficient, which is not really the case.

Few would argue that placement is irrelevant in case of wind turbines and solar panels, the same goes for geothermal plants. Depending on the location and the temperature of water in the reservoir or of the rock formations, the energy outcome may be used either for heating or for energy production. From over 72 countries in the world that make use of this resource, 24 have geothermal power plants [BP Statistical... 2011]. If we take a look at different case studies, the cost-effectiveness of geothermal installations differs from site to site but in comparison with most of the other energy sources, also other renewables, it is much more independent of shortages of supply and the environment. It has to be maintained, but needs no steady inflow of fossil fuels and issues such as wind currents or exposure to the sun are irrelevant for its functioning. What is more, if the sector of geothermal energy was aided in its growth, soon it could benefit from the scale effect thus making the technology cheaper and more accessible on the market.

According to the national plan for renewable energy sources issued by the Polish Ministry of Economy, most credit is given to wind and biomass but it is also mentioned that the number on small hydro plants should increase. The structure of the thermal power sector is to remain as it is, aided, however, by geothermal and solar technologies [*Krajowy plan...* 2010, p. 6]. Although the geothermal and hydro plant technologies form just a small percentage of power generation in Poland, I would like to point to their potential and possible use, highlight their advantages and reasons why geothermal and hydro plants should be important for schemes that aim at facilitating sustainable economic development.

Let us not forget that no European country is obliged to invest in a specific energy source or shut down their coal blocks or nuclear plants altogether. Every country is free to develop their own energy portfolio and the natural resources it uses [*Wersja skonsolidowana...* 2012, art. 194]. Different documents set goals and different requirements that are more or less binding but in most cases leave adequate wiggle room.

4. Local energy generation

One of more important differences between the renewable energy sources and those connected with fossil fuels or radioactive elements, is that these may be implemented locally. In most cases that is also the only reasonable solution. Heavy investments made into large wind farms and photovoltaic projects may serve their purpose in the future but will always need a complex infrastructure to support them. This would encompass medium and long-term energy storage capacities and other energy sources to supplement the unstable output. In Europe, there is also great potential for local power generation from renewable sources what has already been demonstrated by countries such as Denmark and Norway and there are others, like Austria, that are following the same path. Such a strategy is also expressed and endorsed by the EU [Komunikat Komisji... 2012, p. 7].

It is mostly for the significantly lower need for the supporting infrastructure that more credit should be given to more independent renewable energy sources like geothermal installations and hydro plants. This feature makes them all more attractive for local use. The EU policy will play a crucial role here, as the construction of those plants would be too much for the local authorities. However, we should keep in mind that those solutions are also much more sustainable and stable as for their lack of susceptibility to factors of weather and climate change that can have an impact on solar coverage and present wind currents.

Such a strategy would also help Poland to move towards energetic security and independence which is not something that Poland is unable to reach or, should we rather say – regain. In 1975 Poland had energetic independence at the level of 113%, 85% in 2000 [Wywiad z... 2012] and currently it does not exceed 80% and is still diminishing [Gospodarka energetyczna... 2012]. Establishing small energy plants would also help to strengthen the cooperation between regions and institutions. In most cases it would be too expensive for a single municipality to cover all the expenses connected with a geothermal installation, even if aided by the government or EU funds.

One other significant issue connected with the energy sector in Poland is the poor state of the relevant infrastructure which is responsible for the storage, transport and distribution of energy resources. The modernization costs are for sure to be extremely high and stretched over a longer period. Those investments are inevitable but if energy production became more local, the national and European infrastructure could become less complex and easier to maintain. Such an approach would also be in line with the general goal of the Energy Efficiency Directive from October 25, 2012.

5. Small geothermal installations

Polish geothermal potential has already been estimated and plans have been made for its use [Wywiad z... 2012]. Poland has a geothermal potential much bigger than, for example, Germany that is much more active in this field. Plans that are developed there foresee even a 50% share of geothermal installations in heat generation [Gesetz zur... 2012]. Even the location of geothermal installations would not be a problem in Poland, as geothermal waters are under the surface of almost 80% of Polish territory [Antics, Sanner 2007]. It is mostly medium temperature geothermal supply, but that does not mean it cannot be used also to a good financial outcome. Even the lower temperature geothermal resources can be used for commercial power production by utilizing Organic Rankine Cycle units, like at the Chena Hot Springs Resort in Alaska that makes use of the lowest temperature field [Low-temperature... 2012]. Several years ago, low interest in such technologies could have been explained by the lack of information and knowledge about successful geothermal projects being realized in other countries. There was also a problem of legal regulations, poorly documented impact on the environment or the access to necessary equipment.

Presently, the situation has improved but still there is little information about the possible use of the geothermal resources on a broader scale. Heat pumps are becoming more and more popular but mostly with the residential building sector. One of the examples in Poland could be the Podolany residential area in Poznań [Zdrenka 2012]. This development is a good sign for the geothermal industry as it helps to create a popular consent and demand for such solutions that can be recognized as clean and efficient. Geothermal heat pumps can be used almost anywhere as the temperature just a couple of meters below the surface of the Earth is about the same everywhere – between 10 and 15°C. It is, therefore, enough to provide both basic heating and cooling, depending on the season [Wachtel 2010]. Such systems are safe to be built with no health risks to people and can operate almost unnoticed, which is not the case with home wind turbines.

Another issue that is raised regarding the larger geothermal installations is their cost. It is much easier to assess wind conditions than the geothermal potential, but using wind is much more expensive. It is also worth noticing that the cost of generating geothermal power has decreased in the USA by 25% in the last 20 years [Geothermal Energy... (2012)]. Those technologies could also be implemented in Poland but foreign investment is not necessary to realize geothermal solutions, as we already have companies with necessary equipment and skills as well as experience. First Polish geothermal heating plant was built in the early 1990s in Bańska-Biały Dunajec that is currently covering 35% of the demand for heating in Zakopane [Energia... (2012)]. This installation has also been considered a model facility by the American and Japanese specialists.

Whatever is technologically efficient can always be economically efficient. Even if the initial costs of exploration and research can, at first, be deterring, the later cost

is much lower. All types of energy systems require some form of maintenance but the geothermal systems require much less than other renewables and their predicted time of operation is longer. They also do not need any additional fuel and can operate even over 90% of time. For comparison, coal-fired power plants work only 75% of time [Wachtel 2010].

If we consider the potential to produce electric energy, geothermal fields can also be exploited in a sustainable way. Geothermal fields can be exhausted if used in an unsustainable manner and without any regard for the life cycle they go through. Such a life cycle of a geothermal field could be described as passing through four distinct phases: development, sustaining, declining and renewable [DiPippo 2008]. Only during the last phase does a given geothermal resource approach the ideal of a sustainable and renewable resource. What is needed to keep it that way is careful management and making sure that fluid and heat extraction matches the combined recharge. If those conditions are met and there is a market for the produced energy, such a field can operate without the risk of depletion.

There are already geothermal heating plants operating in Poland that consider these conditions, like the one in Pyrzyce with its maximum output being almost 50 MW [Pyrzyce... (2012)]. It is made of four drills that are about 1600 m. deep and placed in an arrangement that allows for rational exploitation. The aim is not to diminish the potential of the geothermal resource. In 2004 the plant was able to cover 59% of the city's thermal demand and helped to save up 20000 tons annually [Pyrzyce... (2012)]. The installation is financed mostly from its own budget (almost 80%) [Ciepłownia... (2012)] which makes it quite independent and efficient. The creation of such plants in Poland would not only be ascribed to the EU goals of sustainable development, but it also gives a significant boost to the national energetic security and independence.

Such a turn will not happen overnight and will be more difficult and expensive from the construction of wind farms and solar plants, but initial investments could pay for themselves in the future. As stated above, low maintenance costs, no need for additional fuel, wide accessibility and the experience of the geothermal plants constructed so far, can help to make the energy sector in Poland more stable. It could also lead to lowering energy prices.

Negotiations with Gazprom have led to a recently announced cut in gas prices [PGNiG... (2012)]. As this is obviously good news both for the industry and the citizens, in the long run it still means dependence on import, while a local power generator (biomass, wind, solar, geothermal, etc.) will always be a safer solution. The challenge here is to develop local energy production and aid it in a way that it can become practical, cheap for the consumers and still remain economically viable for the companies that provide related services.

A lot of communities share this approach. As we can learn from the elaborated version of the remarks to the National Development Strategy 2020 made after social consultations were concluded [Raport... (2012)], there is a will to promote installa-

tions to satisfy local demand for energy. Mentioned were the facilities of capacity not exceeding 10 MW that can get the energy directly to the consumers without the need for it to be transported over large distances. Geothermal plants can also help regional communities to attain their own energetic security which is in line with the Energy Law Act of 10 April 1997 [*Prawo...* 2012].

6. Small hydro plants

Before the Second World War, small hydro plants were much more commonly found in Poland and their number was estimated at about 8000. Those have mostly powered local factories and workshops. During the Polish People's Republic period, their number quickly decreased to the point, that in the 80s there were only 650 such installations registered. Some of them had to be put out of commission for the lack of maintenance and funding but that decline was mostly from political reasons. Hydro plants were thought to be a relic of the capitalistic rule, while the communist ideals should have been realized thanks to heavy industry and the power of coal and other fuels [Sokołowski, Kozłowski, Zimny 2005].

Hydro plants produce just a very small fraction of electric energy in Poland and our country has a very low annual rainfall of about 600 mm, which is also one of the lowest in Europe. Despite these obvious limitations there is no reason not to develop small hydro plants with installed capacity up to 5 MW. Smaller installations are more accessible and much easier and quicker to build which makes them more attractive for local communities and investors.

There are still some well kept and operated hydro plants in Poland, such as the one in Rożnów with its installed capacity of around 50 MW [*Elektrownia...* (2012)]. In its case it is not only the output that is important but also the impact on the local infrastructure and other conditions. The lake that was created in connection with the construction of the dam has made it possible to develop local tourism, water sports and sailing. Those are just exemplary benefits that may come from such projects. Such developments would also force out other issues such as the quality of water in Polish rivers that are mostly 3rd class.

It is hard to find elaborated programs for the development of hydro plants in Poland and the whole issue is limited mostly to individual projects. It is only reasonable that primacy should be given to the transformation of the conventional power sector as it is predominant and of most strategic national importance. It would be advisable to reexamine the locations of the former installations from the first half of the 20th century and consider their reactivation if the efficiency and commercial requirements give such justification. Efficiency may presently be the key word here since the need to be more productive with less resources is currently on the EU agenda and it is quite probable that tangible incentives will follow.

What would also be important in case of small hydro plants is their low maintenance cost and independence from any additional fuels. Coal-fired blocks usually

require serious maintenance much sooner than water turbines. In their case, initial investment pays off much later but can be backed by long durability. That is also a reason for making more complex schemes for introducing such plants that would comprise also of a social compound and other potential impacts and related gains.

7. Conclusions

According to statistics, energy produced in Europe from geothermal fields and from hydro plants was estimated at around 25% of the total energy production from renewable technologies. Over 18% came from hydro plants with wind and solar at only 8% each [*Polityka...* 2012, p. 81]. Although these numbers are changing, especially with new wind farms being built, it would be unwise to invest too heavily into just one or two of the mentioned solutions.

The diversification of energy sources and supplies should not only be conducted on the grounds of favorable trade contracts with the biggest exporters, but it should also take note of the actual on-site conditions that could provide better or safer opportunities for the domestic production. It is vital to make the best possible use of available resources and it is rarely reiterated that Poland has an actual geothermal potential that, if used and managed properly, could prove to be a much better solution than any other that requires shipment of different fuels from abroad or within the country. The conditions for building hydroelectric power plants are less attractive but could still be developed to serve also additional goals such as the improvement of water quality.

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ROZWÓJ MAŁEJ ENERGETYKI GEOTERMALNEJ I WODNEJ W POLSCE W KONTEKŚCIE BEZPIECZEŃSTWA ENERGETYCZNEGO ORAZ ROZWOJU REGIONALNEGO

Streszczenie: Artykuł zawiera krótką charakterystykę sytuacji oraz kierunków rozwoju polskiego sektora energetycznego. Uwzględnia on również szanse i ograniczenia wynikające z ustawodawstwa unijnego. Posiłkując się przykładami z kraju oraz z zagranicy, główny nacisk położono na szanse wykorzystania znacznych zasobów energii geotermalnej w Polsce. Krótki opis cyklu eksploatacji pomaga w lepszym zrozumieniu związku tej technologii ze zrównoważonym rozwojem. W Polsce można również rozwijać energetykę wodną. Powinno się tworzyć złożone plany, uwzględniające m.in. wpływ przedsięwzięć w regionie. Rozwój tych technologii (droższych w konstrukcji lecz tańszych w eksploatacji) może pomóc Polsce stać się bardziej niezależną energetycznie oraz wzmocnić współpracę między regionami.

Słowa kluczowe: energia geotermalna, energetyka wodna, energia odnawialna, zrównoważony rozwój.