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# ANALYSIS OF THE IMPACT OF SOLAR FARM ON THE ENVIRONMENT

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**Abstract:** Photovoltaics is the most rapidly growing renewable source of energy in Poland. More and more people invest in the PV industry. The subject of the article is to show the potential of energy obtained from the Sun on the example of 1 MW photovoltaic farm, which is located in Poland. The article presents characteristics of farm elements and an analysis of the impact of this farm on the environment. The analysis is based on the technical characteristics of the selected farm and the location in which the selected farm is located.
**Keywords:** environment, solar farm, photovoltaics

## 1. INTRODUCTION

Nowadays people need more and more energy. Humanity needs energy in every zone of their life. However, this phenomenon has a negative impact on the environment because energy is produced from conventional energy sources such as carbon or petroleum. Energy production from conventional sources makes air quality worse but there is a simple solution to this problem. Renewable source of energy this is solution. Renewable energy sources are an important element of sustainable development, bringing measurable economic and ecological effects. The use of alternative energy sources instead of fossil fuels is the most effective way to reduce harmful greenhouse gas emissions to the atmosphere. Their application brings ecological effect both on a local and global scale. The most popular is energy from the Sun. Solar power is a 100% clean, renewable energy source. The second advantage is that this technology is universal, because in almost anywhere you can install properly selected modules: on the roofs of single-family houses, industrial plants or on independent components. The subject of this article is to show the potential of energy obtained from the Sun on the example of 1 MW photovoltaic farm, which is located in Poland. The article presents characteristics of farm elements and an analysis of the impact of this farm on the environment. [1]

## 2. PHOTOVOLTAICS

Photovoltaics is a zero-emission type of technology during work, it doesn't emit any pollutions into the environment. Photovoltaic panels convert solar energy into electricity. Many types of materials are now known for achieving photovoltaic effect. The basic element of the installation are photovoltaic cells, which are combined into PV modules. A photovoltaic phenomenon occurs in the cells, thanks to which the energy from the sun is transformed into direct current. Cells are systems made of semiconductor material that conducts electric charge as a result of external factors, including in the form of temperature or solar radiation. In industry cells based on monocrystalline silicon are most commonly used but also cells based on polycrystalline silicon, amorphous silicon, polymers, cadmium telluride and many others. Currently the most popular panel types are: monocrystalline modules and polycrystalline modules (fig 1). These solar panels differ primarily in design, appearance, performance and costs. The production process of polycrystalline panels is cheaper than the production of monocrystalline panels. The amount of waste generated during the production of polycrystalline panels is also smaller, which makes production cheaper and therefore also the entire installation is cheaper. Polycrystalline panels operate with an efficiency of around 14-16%, which means that they are still less efficient than monocrystalline panels. [1, 2]

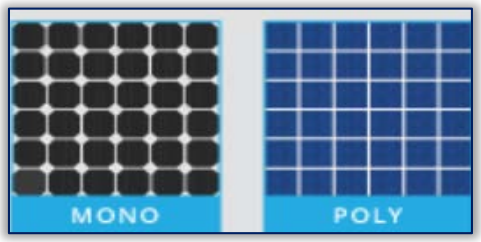

Figure 1. Type of PV panels [3]

## 3. SOLAR RADIATION

Although it would seem that the highest efficiency of PV panels is achieved in the countries of the Mediterranean climate. It turns out that the creation of photovoltaic installations makes the most sense in the temperate climate zone, because this zone avoids excessive heating of the panels surface, which in consequence doesn't cause a decrease in their efficiency. The intensity of solar radiation in Poland per 1 m² of the horizontal plane ranges between 900 - 1200 kWh/m² depending on the area. This means that from a 1 kW photovoltaic installation in Poland under optimal conditions about 900 -950 kWh of electricity can be obtained during the year. The investment that is the subject of the article is located in the zone where the sun exposure is 1000 kWh/m² (figure 2). [1, 4]

## 4. RESEARCH OBJECT

The planned investment which is a research object consists in the construction of a photovoltaic farm, whose goal will be the production of electricity and its introduction into the National Power System. The photovoltaic farm will be located in the east Poland, 84 kilometers from Warsaw. The farm will include:

— 3 120 monocrystalline panels with a power of 320 Wp,
— 7 inverters,
— technical building with a transformer inside,
— necessary fence with 20 cm space between fence and ground (fig. 3) (it is needed in order small animals could migrate in this area).

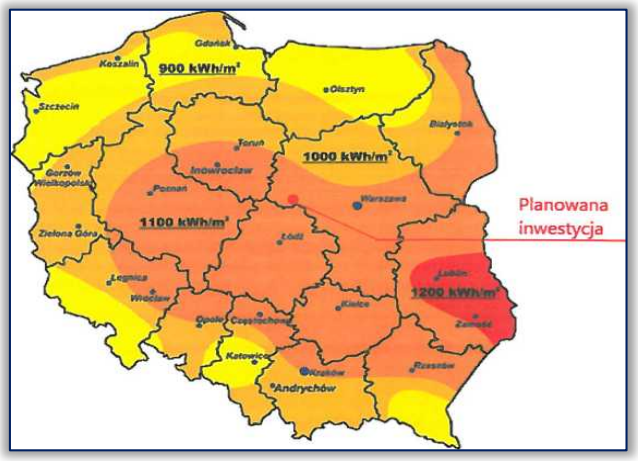


Figure 2. Yearly sum of global irradiation [4]

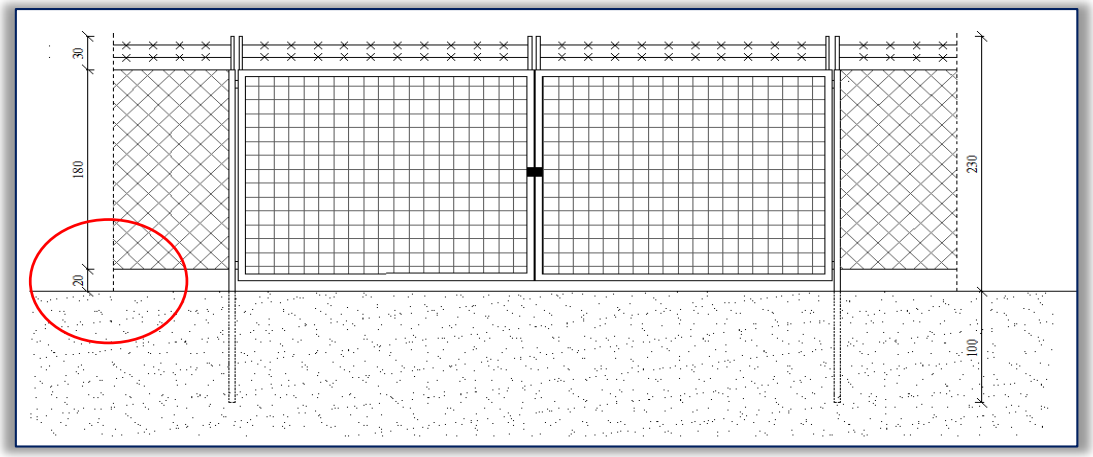


Figure 3. Fence with 20 cm space between fence and ground [own elaboration]

The area of the planned project is arable land and is currently used for agriculture. The area of photovoltaic farms is characterized by a large share of biologically active areas where plant vegetation occurs. Only about 0.2 ha will be considered as completely excluded from vegetation (contact points between the structure and the ground, area occupied by the transformer station, string boxes, technological road, maneuvering area and fence). The area of the planned installation will be able to be used by small animals, because a 20 cm space between the ground surface and the bottom edge of the fence has been designed. The planned installation will also haven't a negative impact on bats because panels will be located at an angle 26 degrees, so they won't create a compact surface.

## 5. NOISE EMISSION

Noise emission to the environment at the stage of operation of the planned project will be associated only with the means of transport necessary for maintenance work and the grass mowing equipment used probably 2-3 times a year.

During solar farm work inverters are the only devices that introduce noise into the environment during farm exploitation. This noise doesn't exceed 50 DB (fig. 4). It's similar to noise which we can hear during the night when windows are opened.

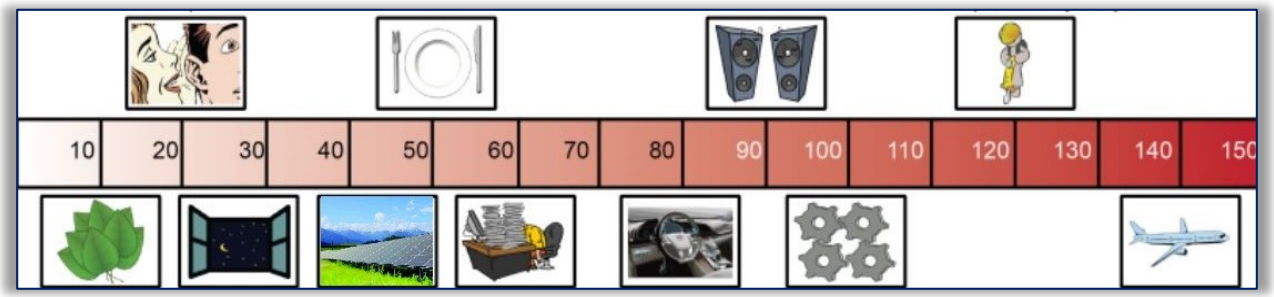


Figure 4. Emission of noise from various elements [5]

## 6. EMISSION OF POLLUTIONS

Emission of pollutions into the air will occur only at the stage of building the installation and decommissioning it may take place only during transport of materials, work of technical equipment and machinery. However, this period will last no more than a few or several weeks. Emissions of air pollutions will be short-term and temporary. When the construction phase will be completed, emission of pollutions will be also completed. After the completion of construction works, the air will return to the state before the building is completed.

During construction, construction machines will work on the investment site. The subject of emissions of substances into the air are most often: products of fuel combustion, mineral dusts, possible gases and other chemical substances. Machines such as trucks, a metal pole nailer, burn diesel in diesel engines and cause emissions of nitrogen oxides, carbon oxides and emissions of sulfur oxides (tab. 1). The amount of emissions and composition of exhaust gas emissions of vehicles are a function of many factors. The highest gas emissions occur at low engine speeds, during engine start-up, at low speed and braking.

Table 1. Emission data refer to the work of 4 construction machines, which produce emission NOx, PM10, CO and benzene [own elaboration]

| Emission | Amount |
|---|---|
| NOx | 3,24 kg/h |
| PM10 | 0,15 kg/h |
| CO | 1,05 kg/h |
| Benzene | 0,0003 kg/h |

The creation of a solar farm is also associated with the generation of waste at the construction stage (tab. 2). Waste management will consist in preventing its generation and minimizing the amount of generated waste. All generated waste will be selectively stored and then recycled or disposed of. Waste appearing during the construction and operation of the farm include for example paper or metal packaging, iron, steel and filter materials.

Table 2. Types of waste at the construction stage [own elaboration]

| Type of waste | Estimated mass of waste generated [Mg] |
|---|---|
| Paper packaging | 0,1 |
| Wood packaging | 0,25 |
| Metal packaging | 0,1 |
| Filter materials | 0,001 |
| Waste from repairs | 2 |
| Iron and steel | 1 |
| Wires | 0,25 |
| Soil | 100 |

## 7. RECYCLING PROCESS

The service life of solar panels is 25 - 35 years. No waste is expected during farm operation. After a period of use, the used panels will be forwarded to a specialist company and recycled. Currently, the problem turns out to be the development of optimal technology and estimation of investment costs of recycling installations. Panel recycling is a very important issue due to the limited amount of pure silicon for the production of PV cells. Therefore, there is a need to recover it.

The recycling of used or damaged silicon PV modules is based on the application of two main stages (fig. 5):

— separation of PV cells in this process, the incoming cells are separated from the rest of the panel elements - this happens through thermal or chemical processes,

— surface cleaning of PV cells. During this stage, the cells separated from the panels are cleaned. At this stage unwanted layers are removed (for example a p-n or anti-reflective junction). It is important that the removal of individual layers is carried out in a way that enables the reuse of silicon. [6, 7]

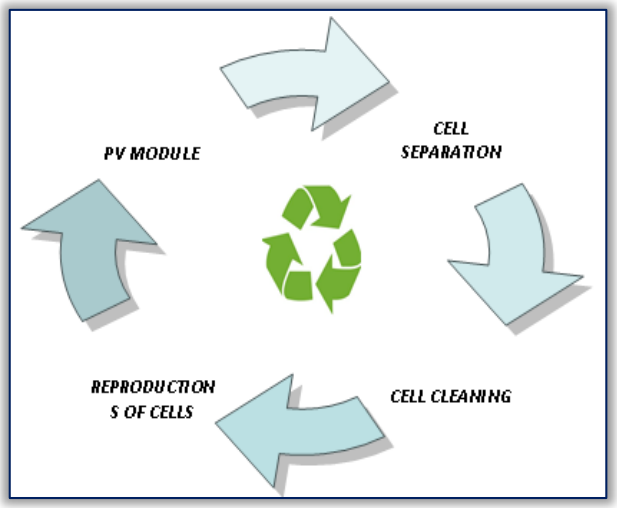


Figure 5. The recycling process [own elabortion]

## 8. SUMMARY

A solar power plant that produces energy from solar radiation helps reduce the amount of greenhouse gases it produces. It is estimated that compared to the production of electricity based on fossil fuels. Each kW of solar installation saves up to 8 kg NOx and 4.5 kg SOx from 300 to 1100 kg carbon dioxide depending on the fuel composition and solar radiation intensity. Photovoltaics is becoming a popular solution to problems that affect the deterioration of the environment around the world. This is influenced by the fact that PV panels:

— don't emit exhaust,
— don't require the supply of fossil fuels,
— don't make noise.

They also have little effect on flora and fauna in the area. If necessary, photovoltaic panels can always be easily disassembled and the area where the farm was located will soon return to the state before construction. [2, 6]

**Note:**

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