# RESEARCH ON REDUCING PM10 PARTICLES IN THE JIU VALLEY AREA AS A RESULT OF USING PHOTOVOLTAIC PANELS IN ELECTRICITY PRODUCTION

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**Abstract:** Air quality in industrial areas is a pressing concern due to its significant impact on public health and the environment, especially regarding PM10 particle pollution. Effectively mitigating these risks requires practical solutions. The adoption of photovoltaic panels for energy production emerges as an attractive option to address environmental pollution and promote sustainable development. This study aims to comprehensively analyze the potential of photovoltaic panels in reducing PM10 particle levels in the Jiu Valley region, an area primarily dominated by the mining industry. The research includes an assessment of air quality and PM10 particle pollution levels in the Jiu Valley, along with a detailed analysis of the energy potential of photovoltaic panels in the region. Statistical analysis was conducted to compare PM10 particle levels in the air with and without the use of photovoltaic panels, particularly in relation to those emitted by the mining industry. The findings provide valuable insights into the effectiveness of photovoltaic panels in mitigating PM10 particle pollution in the Jiu Valley, thus advocating for a sustainable approach to managing air quality in industrial areas.

**Key words:** air quality, photovoltaic panels, pollution, environment, industrial areas.

## 1. INTRODUCTION

Air pollution is a pressing concern, particularly in regions characterized by intensive mining and coal-fired power generation. The mining industry and associated activities contribute significantly to atmospheric pollution, releasing particulate matter and other pollutants into the air. Of particular concern are particulate matter with a diameter of less than 10 micrometers (PM10), which pose serious health risks due to

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their ability to penetrate deep into the respiratory system. In this context, the reduction of pollution from coal-fired power plants is paramount [1], [21], [23] [25], [28].

These facilities are major sources of air pollutants, emitting significant amounts of PM10 particles, Sulphur dioxide (SO2), nitrogen oxides (NOx), and other harmful substances into the atmosphere [2]. Efforts to mitigate pollution from coal-fired power generation are critical for safeguarding public health and mitigating environmental degradation [3], [4]. One potential solution being explored is the adoption of cleaner energy technologies, such as photovoltaic (PV) solar panels, as alternatives to coal-fired power plants [5]. By harnessing solar energy to generate electricity, PV panels offer a sustainable and environmentally friendly alternative to traditional coal-based power generation. This shift towards renewable energy sources has the potential to significantly reduce air pollution, improve air quality, and mitigate the adverse health effects associated with coal-fired power generation [6], [22], [24].

PM10 particles are a type of air pollutant consisting of solid and liquid particles suspended in the air, with a diameter of less than 10 micrometers. These particles are highly diverse in composition, including dust, smoke, smog, and other fine substances, and their sources can vary, including industrial, vehicular, agricultural, or natural processes such as soil erosion. Due to their small size, PM10 particles can be inhaled and penetrate deeply into the human respiratory system. The effects of PM10 particles on human health are considerable and varied. These particles can cause irritation of the respiratory tract, exacerbating symptoms of asthma and other lung conditions. Moreover, PM10 particles can enter the bloodstream, having harmful effects on the cardiovascular system and increasing the risk of conditions such as heart attacks and strokes. Additionally, exposure to PM10 is associated with increased premature mortality, hospital admissions, and other health problems [7], [26], [29].

The Jiu Valley, situated in southwestern Romania, stands as one of the country's significant mining centers, boasting a longstanding tradition in coal extraction. Over the years, mining has served as the primary economic driver in the region, providing employment opportunities and contributing to local development. However, with the decline in coal usage as a primary energy source, the Jiu Valley has faced a challenging transition towards more sustainable alternatives. Resizing mining activities and the closure of certain mines became inevitable with changes in the energy industry and growing concerns regarding the environment. Nonetheless, these transition actions have not been without challenges, and one of the most significant issues is the air pollution specific to the area. The mining industry and related activities have been the primary contributors to air pollution in the Jiu Valley. Processes involved in coal extraction and processing have generated significant emissions of particulate matter, noxious gases, and other atmospheric pollutants. This pollution has had a significant impact on the quality of life of residents in the area, directly affecting community health and well-being. Monitoring air quality in the Jiu Valley has become a priority for authorities in an attempt to understand and manage the pollution's impact on human health and the surrounding environment. Sampling campaigns and data analysis have revealed elevated levels of particulate matter, nitrogen oxides, and other toxic substances in the air breathed by residents in the area [8], [30], [33], [35], [36].

Addressing this issue requires an integrated approach and cooperation among various stakeholders, including local authorities, mining companies, local communities, and non-governmental organizations. Investments in cleaner and more sustainable technologies, as well as the promotion of renewable energy, can contribute to reducing pollution and improving air quality in the Jiu Valley [9]. Ultimately, managing pollution in the Jiu Valley represents not only a challenge but also an opportunity to transform the region into a healthier and more sustainable place where people can live and work in a safe and clean environment [29], [31], [32], [34].

In the Jiu Valley, where air pollution, especially PM10 particles, poses a significant challenge, the deployment of photovoltaic panels represents a promising solution for reducing the pollutant impact of industrial and mining activities. Photovoltaic panels are devices that convert sunlight into electrical energy without emitting pollutants into the atmosphere or generating waste. These panels can be installed on buildings, open land, or specially constructed structures, generating clean electrical energy that can be used to power local consumers or integrated into electrical grids. By harnessing solar energy, dependence on traditional energy sources such as coal, which are associated with significant emissions of PM10 particles and other atmospheric pollutants, can be reduced.

Moreover, installing photovoltaic panels can contribute to diversifying the region's energy mix and increasing renewable energy production capacity. This can have long-term benefits for the environment and the health of residents by reducing air pollution and improving air quality. In addition to the environmental benefits, implementing photovoltaic panels in the Jiu Valley can create economic and local development opportunities. The construction and installation of these systems require local labor and resources, which can stimulate economic growth and job creation in the community [9]. In the specialized literature, there are scientific papers that analyze the impact of pollution on the production of electricity from renewable sources, as well as the impact of the use of sustainable (non-polluting) electricity production installations on the reduction of pollution in certain areas of the world.

In the paper by Mardani, Hoseinzadeh and Garcia [10], the impact of aerosols on solar power generation in Tehran, Iran is explored. Tehran, despite its high solar energy potential due to significant levels of solar radiation, faces severe air pollution challenges. This study aims to develop predictive models for solar attenuation caused by particulate matter (PM2.5 and PM10) using both remote sensing data from the NASA CERES syn 1-deg product and local observations from 2014 to 2020.The researchers found that the models performed better in predicting aerosol attenuation in the colder months (November, December, January) with correlation coefficients of 0.1553, 0.2926 and 0.1341, respectively. On average, aerosols accounted for a loss of 8.30% of total solar radiation. This was validated with RMSE and MBD values of 14.09% and 10.89%.The study highlights the significant impact of aerosols on solar power generation and suggests that the developed models can improve the feasibility and siting of PV plants by considering the attenuation effects of aerosols [10], [27].

In the work of Zheng, Lu, and Zhao [11], the impact of high-velocity longitudinal airflow on dust removal and power output characteristics of photovoltaic (PV) panels is explored. The study investigates how dust accumulation on photovoltaic panels decreases their photoelectric conversion efficiency and proposes a dust removal method using high-speed longitudinal airflow to improve output power. Using commercial CFD software, researchers simulate the dust removal process and establish a model to analyze the output characteristics of PV panels under the influence of high-velocity air flow.The study examines various factors such as tilt angles, dust particle sizes, airflow velocities and blowing times to determine their effects on dust removal efficiency. The results show that as the tilt angle, airflow velocity, and blowing time increase, the dust removal rate and output power of the PV panel also increase. The optimal conditions for dust removal are identified, demonstrating significant improvements in power output, which can guide the practical application of high-velocity airflow in maintaining PV panel efficiency [11].

In the paper by Khan and Bounade [12], the authors explore strategies to mitigate PM2.5 air pollution in OECD countries. The study investigates the effects of green investment, digitalization, renewable energy and economic growth on PM2.5 air pollution over the period 1990-2020. The authors use advanced econometric techniques, especially the quantile moment regression method (MMQREG), to analyze the data. Their findings indicate that green investments, digitization and renewable energy have a significant positive impact on reducing PM2.5 air pollution, while economic growth tends to exacerbate it. The study highlights the importance of adopting a holistic approach that combines green investment and digitization to effectively mitigate PM2.5 pollution, protect public health and promote sustainable economic growth. The paper also highlights the critical role of renewable energy and green investments in achieving long-term environmental sustainability. It calls on decision-makers to implement support measures for green technologies and digital solutions to improve air quality. In addition, the study provides insights into the different effects of these factors in different quantiles, providing a comprehensive understanding of their impact on PM2.5 air pollution. The authors conclude by recommending policies that encourage green investment and digitization as key strategies to reduce air pollution and promote sustainable development in OECD countries. The paper contributes to the existing literature by providing empirical evidence of the benefits of integrating green and digital technologies into environmental policy frameworks [12].

In the paper of Haramaini et al. [13], the authors investigate how socio-economic factors influence the adoption of solar panels in urban areas of developing countries. This study uses a quantitative, associative research method and uses correlation analysis to understand the relationship between variables such as education level, income, and public perception of alternative energy with the use of solar panels. The study identifies several key socio-economic factors that significantly affect solar panel adoption, including number of prosumers, total kWh exports, gross regional domestic product (GRDP), total investment, total electricity load, EV home load and air quality. The research demonstrates that there are distinct relationships between these socio-economic variables and solar panel adoption, highlighting the importance of factors such as government policies, economic resources and environmental awareness in promoting the use of renewable energy. The results suggest that higher levels of education and income are positively correlated with increased adoption of solar panels, while factors such as proximity to the capital and better air quality also play significant roles. The findings provide valuable information for policy makers to formulate effective strategies to promote solar energy, ensure sustainable energy development and reduce environmental impact in urban areas of developing countries [13].

In the paper of Bošnjaković et al. [14], the authors analyze the environmental effects of photovoltaic (PV) plants. The study highlights the importance of renewable energy, especially photovoltaic and wind, in addressing climate change and increasing energy security. However, PV plants have environmental impacts such as greenhouse gas (GHG) emissions, land use, water consumption and waste generation.Although the operation of PV plants generates minimal emissions, significant emissions occur during the production, transport and installation of the components. These emissions will decrease with the increase in the share of renewable energy and the improvement of production technologies. Land use for PV installations is a critical issue, and the authors estimate that there is sufficient land available, but emphasize the need for careful planning to minimize impacts. Water consumption in PV systems is relatively low, but manufacturing and recycling processes can consume significant amounts of water, requiring full life cycle assessments.Biodiversity impacts include habitat loss due to deforestation for PV installations, although well-managed solar farms can increase biodiversity. Noise pollution from inverters, transformers and cooling fans is another issue addressed, with recommendations for noise reduction. End-of-life management of PV systems emphasizes the need for efficient recycling and reuse to minimize waste. A significant increase in PV waste is predicted until 2050, highlighting the importance of developing sustainable recycling technologies and policies [14].

## 2. MATERIALS AND METHODS

Solar energy represents a promising and sustainable solution for meeting the growing global demand for electricity. Among the key components of solar energy systems are solar panels, which capture sunlight and convert it into usable electrical energy. In this chapter, we explore three main types of solar panels: monocrystalline, polycrystalline, and thin-film. Each type has its own unique characteristics, advantages, and applications.

Monocrystalline solar panels are made from single-crystal silicon, giving them a uniform appearance and high efficiency. They are known for their sleek black appearance and superior performance in areas with limited space. Monocrystalline panels are often used in residential and commercial installations where space is a premium and maximum efficiency is desired.

Polycrystalline solar panels are manufactured from multiple silicon crystals, resulting in a speckled blue appearance. While slightly less efficient than monocrystalline panels, polycrystalline panels offer a cost-effective solution for larger installations where space is not a constraint. They are commonly used in utility-scale solar farms and large commercial projects.

Thin-film solar panels are constructed using thin layers of photovoltaic material deposited onto a substrate, such as glass or plastic. They are lightweight, flexible, and less expensive to produce compared to crystalline silicon panels. Thin-film panels are suitable for applications where weight, flexibility, or aesthetics are important factors, such as building-integrated photovoltaics (BIPV) and portable electronic devices.

To assess the performance of these solar panel types in the Petrosani region, we collected climate data, including average temperatures, sunlight duration, and cloud cover, from reliable sources. Using MATLAB, we conducted a comprehensive analysis to estimate the energy output of each panel type throughout the year. MATLAB, a high-level programming and numeric computing platform, enabled us to simulate and model the performance of solar panels accurately. By correlating the climatic variables with solar panel performance, we validated our results and gained insights into the suitability of different panel types for the local climate conditions. Through this analysis, we aim to provide valuable insights into the selection and deployment of solar energy systems in the Petrosani region, ultimately contributing to the transition towards a more sustainable and renewable energy future.The climate data provided in the tabular format below has been obtained from specialized sources (National Meteorological Administration of Romania) [15] and describes the climatic conditions of the Jiu Valley region, particularly Petrosani, Hunedoara. These data points encompass various meteorological parameters crucial for understanding the environmental context and assessing the feasibility of solar energy utilization in the region.

*Table 1.* ***Climatic data from Petrosani [15]***

| Month | Avg. Min Temp (°C) | Avg. Max Temp (°C) | Sunny Days | Partially Cloudy Days | Overcast Days | Rainy Days |
|---|---|---|---|---|---|---|
| January | -3 | 3 | 5 | 10.8 | 15.2 | 12.3 |
| February | -3 | 3 | 4 | 9.5 | 14.8 | 12.9 |
| March | 1 | 7 | 3.7 | 11.8 | 15.5 | 15.4 |
| April | 6 | 14 | 3.6 | 14 | 12.4 | 17.4 |
| May | 11 | 19 | 2.5 | 17.6 | 11 | 19 |
| June | 14 | 22 | 3.8 | 18.4 | 7.8 | 18 |
| July | 17 | 25 | 6.8 | 19.1 | 5.1 | 15.8 |
| August | 17 | 25 | 7.2 | 17.8 | 5.9 | 12.8 |
| September | 13 | 20 | 6.1 | 13.5 | 10.5 | 11.6 |
| October | 8 | 16 | 7.8 | 11.5 | 11.7 | 11.2 |
| November | 3 | 9 | 6 | 10.4 | 13.5 | 12.3 |
| December | -2 | 4 | 6.9 | 9 | 9 | 13.3 |

These data points (Table 1) encompass average minimum and maximum temperatures, the number of sunny days, partially cloudy days, overcast days, and rainy days for each month of the year. They serve as fundamental inputs for analyzing the solar potential and suitability of implementing solar panel systems in the region. By considering these climatic factors, one can assess the expected performance and efficiency of solar panels in harnessing solar energy throughout the year. Additionally, these data aid in formulating strategies for optimizing solar energy utilization and mitigating potential environmental impacts.

## 3. RESULTS

The first step in our entire research was the interpretation and visualization of climate data for the region of Jiul Valley, Petrosani, Hunedoara, using the MATLAB programming language [16], [17]. We imported the climate data and stored this information in appropriate variables, including the average minimum and maximum temperatures for each month, as well as the number of sunny, partly cloudy, cloudy, and rainy days [18]. Then using this organized data, we made the performance graph of the electricity production estimated to be produced for monocrystalline, polycrystalline and thin film solar panels for each month of the year in Petrosani, (Fig 1).

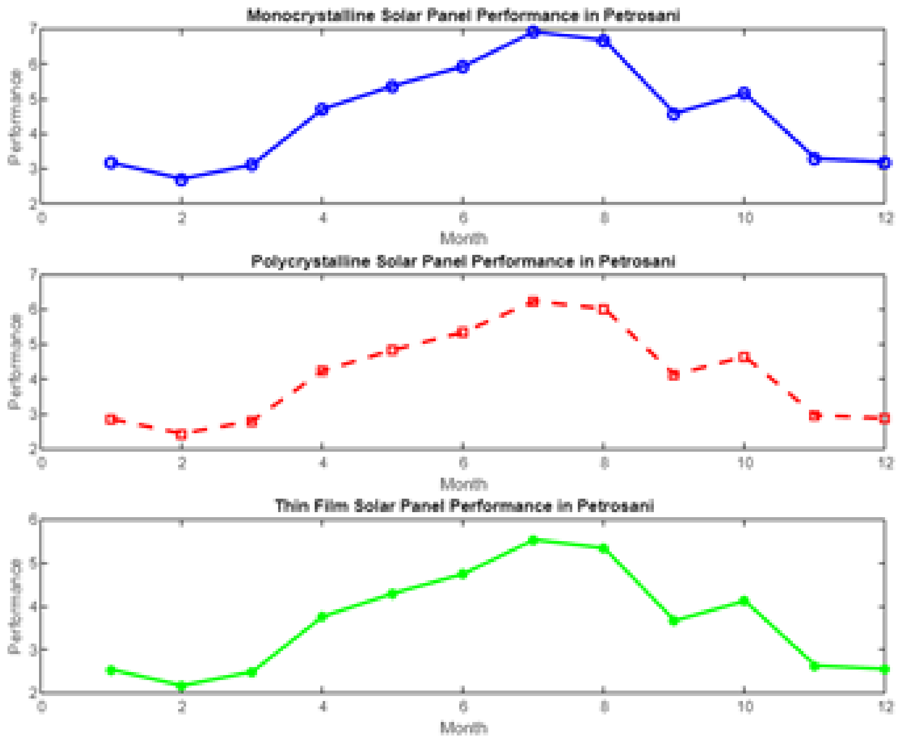


**Fig. 1.** Solar panel performance graph

In our analysis, we observed that monocrystalline panels consistently exhibited the highest energy output throughout the year. This is attributed to their higher efficiency and superior performance in varying light conditions. Monocrystalline panels are particularly effective during periods of low sunlight, such as winter months, making them well-suited for regions with fluctuating weather patterns like Petrosani.

Polycrystalline panels also demonstrated satisfactory performance, albeit slightly lower than monocrystalline panels. Their cost-effectiveness and moderate efficiency make them a viable option for larger installations where space is not a constraint. However, their energy output may fluctuate more significantly in response to changes in sunlight intensity.

Thin-film panels, while lightweight and flexible, exhibited the lowest energy output among the three types. Despite their lower efficiency, thin-film panels offer advantages in specific applications where weight and flexibility are critical factors. However, in Petrosani's climate, characterized by seasonal variations in sunlight and temperature, thin-film panels may not be the most efficient choice for maximizing energy production.

The temperature graph illustrates the monthly variation in average minimum and maximum temperatures in Petrosani (Fig 2). We observed that temperatures tend to be lowest during winter months (December to February) and highest during summer months (June to August). These temperature fluctuations can impact the performance of solar panels, with higher temperatures generally leading to decreased efficiency.

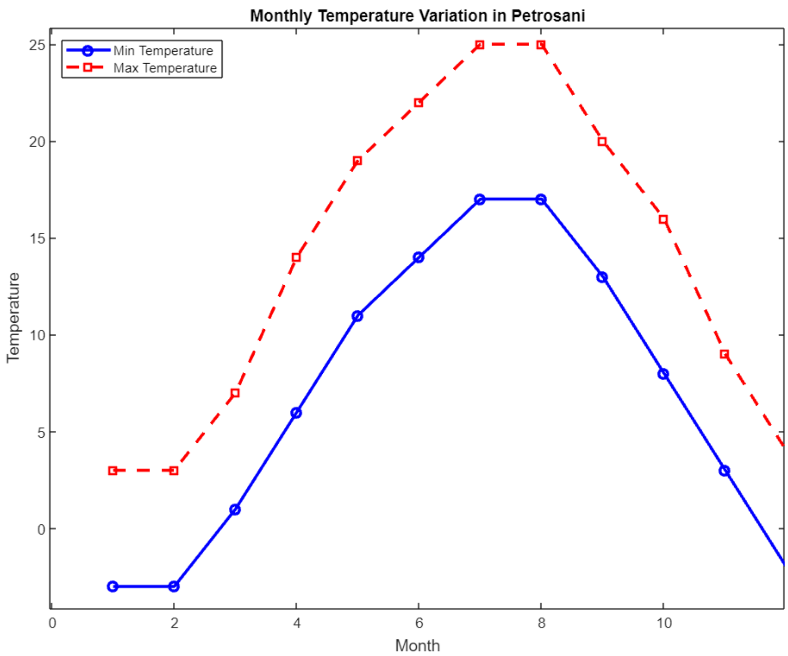


**Fig. 2.** Temperature Variation

The sunlight and cloud cover graph depicts the number of sunny, partially cloudy, overcast, and rainy days for each month (Fig 3). We found that Petrosani experiences a relatively high number of sunny days during summer months, which corresponds to increased solar energy production. However, the region also experiences frequent cloud cover and rainy days, particularly during spring and autumn, which can reduce solar panel efficiency.

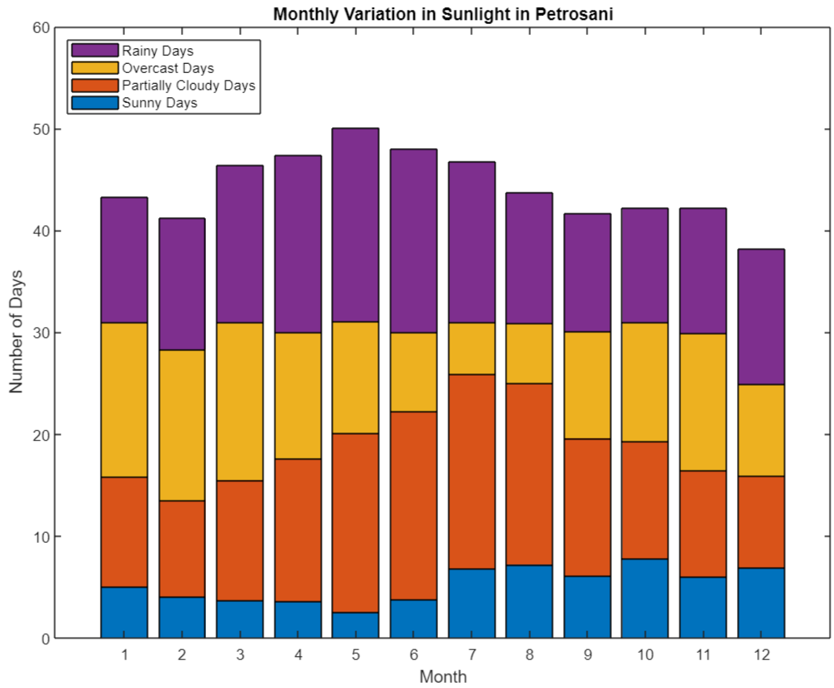


**Fig. 3.** Sunlight and cloud cover in Petrosani

By analyzing these results (Fig 4), we can gain valuable insights into the performance of different solar panel types in Petrosani's climate. Monocrystalline panels emerge as the most reliable option for consistent energy production throughout the year, followed by polycrystalline panels. Thin-film panels, while offering flexibility, may not be the optimal choice for maximizing energy output in Petrosani's climate. These findings can inform decision-making processes regarding the selection and deployment of solar energy systems in the region, contributing to the transition towards a sustainable energy future.

The research aimed to evaluate through a realistic simulation the potential reduction of PM10 particles in Petrosani through the implementation of photovoltaic (PV) panels for the production of electricity. Petrosani currently faces significant air pollution with an annual average concentration of PM10 at 35 μg/m³, mainly due to coal-fired power generation and other sources such as mining operations and industrial activities [19]. In order to make a realistic simulation, we took into account the total annual electricity consumption in Petrosani, which includes the residential, commercial and industrial sectors. The population of Petrosani is approximately 31,044 inhabitants, and the average consumption of electricity per capita is 2,800 kWh per year. This results in a total residential consumption of 86.9 GWh. In addition, taking into account the energy consumption of the commercial, industrial and institutional sectors, we estimate an additional 50% on top of residential consumption, bringing the total commercial, industrial and institutional consumption to 130.35 GWh. Therefore, the total annual combined electricity consumption is 217.25 GWh.

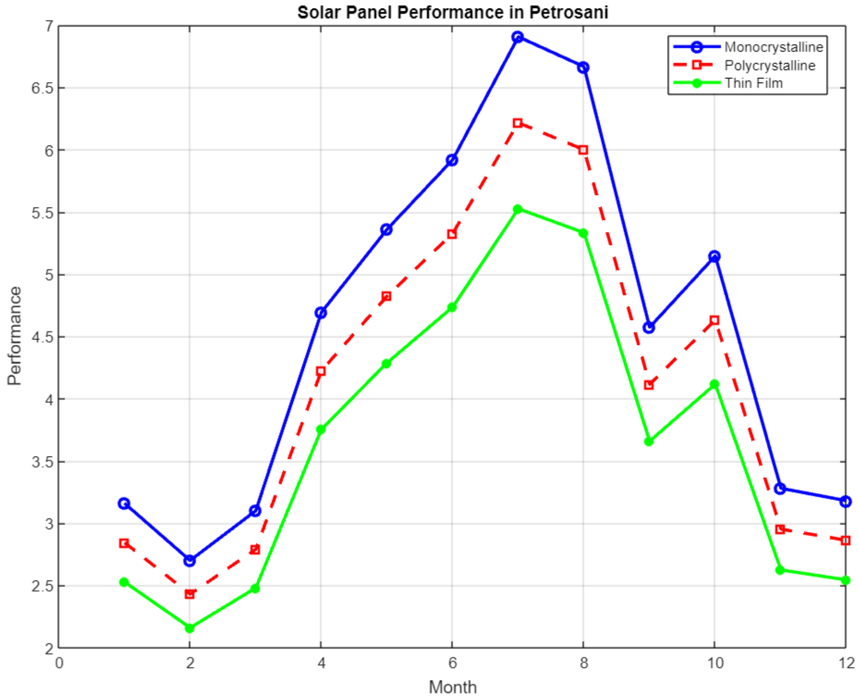


**Fig. 4.** Solar panel performance in Petrosani

Initially, 90% of Petroșani's energy comes from coal, contributing significantly to PM10 emissions, the remaining 10% from renewable sources. The simulation assumes a gradual increase in the proportion of solar energy by 10% annually, up to a realistic maximum limit of the PV installation, starting from an estimated current coverage of 0.5 km² and aiming to cover approximately 5 km² by the end of the simulation period. The photovoltaic panels have an efficiency of 18% and the average daily solar radiation is about 5 kWh/m² for sunny days.

PM10 emission factors include contributions from power generation (coal) at 0.1 µg/m³ per MWh and from other sources such as mine tailings and traffic, which account for 50% of the initial PM10 concentration.

The simulation integrates these data points and assumptions to model the potential reduction in PM10 concentrations over a 10-year period by gradually installing solar panels, replacing coal-fired power. The concentration of PM10 from other sources remains constant to ensure a realistic model.

The results showed a steady decrease in PM10 concentrations over a 10-year period (Fig 5). Initially, PM10 levels saw moderate reductions as the proportion of solar power in the electricity mix gradually increased. Each year, the area covered by photovoltaic panels increased by 10%, which corresponded to a greater amount of coal-based energy being replaced by solar energy. By the end of the ten-year period, PM10 levels had fallen significantly, reflecting the impact of increased use of solar panels. However, PM10 concentrations never fell below contributions from other sources, ensuring that the model remained realistic and not overly optimistic.

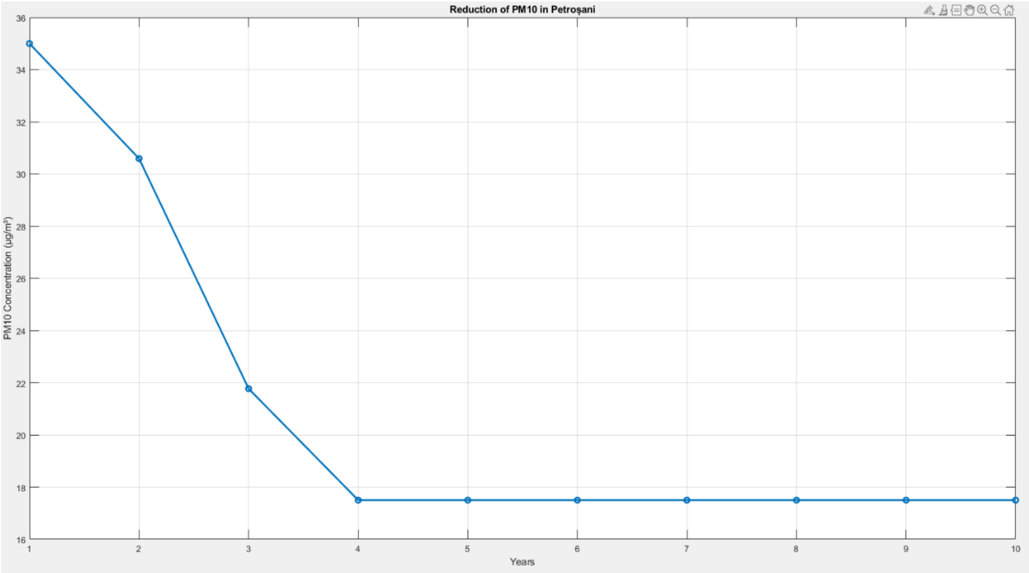


**Fig. 5.** Simulation of gradual reduction of PM10 concentration in Petrosani through the implementation of photovoltaic panels

The implementation of photovoltaic panels in Petrosani demonstrates the potential to significantly reduce PM10 levels, helping to improve air quality. However, persistent contributions from other sources of PM10, such as mining operations and industrial activities, highlight the need for a comprehensive approach to pollution reduction. Addressing all major contributors is crucial to ensuring a cleaner environment in Petrosani. This research highlights the importance of integrating renewable energy solutions while simultaneously managing other sources of pollution to achieve substantial air quality improvements. The data and results obtained are based on the assumption that approximately 5 km² of solar panels will be installed during the simulation period.

The conducted study demonstrates a significant decrease in the levels of PM10 particles in the air when photovoltaic panels are used compared to periods without their use.

The results comparing the reduction of PM10 particle levels achieved by the photovoltaic panels with the emissions from the mining industry, offer a perspective on the efficiency of this renewable energy solution.The analysis reveals the potential energy generation capacity of photovoltaic panels in the Jiu Valley region, highlighting their role in sustainable energy production [20].

## 4. CONCLUSIONS

The study clearly demonstrates that the implementation of photovoltaic (PV) panels in Petrosani has a significant potential to reduce PM10 levels. Through a realistic simulation, taking into account the total annual electricity consumption and the gradual increase in the installation of photovoltaic panels, the research highlights several key findings.

First, the switch from coal-based energy to solar energy can lead to a substantial decrease in PM10 concentrations. The simulation showed a consistent and gradual reduction in PM10 levels over the ten-year period, confirming that increasing the share of solar energy in the electricity mix effectively reduces emissions from coal-fired power plants. This reduction is crucial to improving air quality and mitigating the negative health effects associated with PM10 particles.

Second, the results highlight the importance of a gradual and planned approach to the adoption of renewable energy. Starting from a modest initial coverage of 0.5 km² and aiming to cover approximately 5 km² by the end of the simulation period, the study illustrates how systematic and incremental increases in solar power capacity can achieve significant environmental benefits. This approach ensures that the transition is both feasible and sustainable.

In addition, the findings highlight that while solar power can significantly reduce PM10 levels, other sources of PM10, such as mining operations and industrial activities, remain a challenge. The simulation accounted for constant contributions from these sources, ensuring that the model remained realistic. Therefore, a comprehensive pollution management strategy addressing all major contributors is essential to achieve substantial improvements in air quality.

The study also highlights the dual benefits of adopting photovoltaic panels. Beyond reducing PM10 levels, the transition to renewable energy contributes to broader environmental sustainability goals. It helps reduce dependence on fossil fuels, reduce greenhouse gas emissions and promote cleaner, healthier air for local people.

In conclusion, the implementation of photovoltaic panels in Petrosani is a promising solution for reducing PM10 levels and improving air quality. The research provides valuable insights into the potential environmental and health benefits of renewable energy adoption. It also highlights the need for an integrated approach to pollution management that addresses both energy production and other significant sources of PM10. By continuing to invest in and support the adoption of renewable energy technologies, Petrosani can pave the way to a cleaner and more sustainable future for its residents and the wider Jiu Valley region.

## REFERENCES

**[1]. Zhou S., He, H., Zhang L., Zhao W., Wang, F.,** *A Data-Driven Method to Monitor Carbon Dioxide Emissions of Coal-Fired Power Plants. Energies,* 16(4), 1646, 2023.

**[2]. Nnaji C. C., Chibueze C., Afangideh C. B.,** *The menace and mitigation of air pollution in the built environment: A review.* Nigerian Journal of Technology, pp. 12-29, 2023.

**[3]. Deonarine A., Schwartz G. E., Ruhl L. S.,** *Environmental Impacts of Coal Combustion Residuals: Current Understanding and Future Perspectives.* Environmental Science & Technology, 57(5), pp. 1855-1869, 2023.

**[4]. Gopinathan P., Subramani T., Barbosa S., Yuvaraj D.,** *Environmental impact and health risk assessment due to coal mining and utilization.* Environmental Geochemistry and Health, 45(10), pp. 6915-6922, 2023.

**[5]. Hasan M. M., Hossain S., Mofijur M., Kabir Z., Badruddin I. A., Yunus Khan T. M., Jassim E.,** *Harnessing solar power: a review of photovoltaic innovations, solar thermal systems, and the dawn of energy storage solutions.* Energies, 16(18), 6456, 2023.

**[6]. Yanto D. T. P., Akhmadeev R., Hamad H. S., Alawadi A. H. R., Abdullayev A. B., Romero-Parra R. M., Fooladi H.,** *Development and investigation of a pollutants emission reduction process from a coal-gasification power plant integrated with fuel cell and solar energy.* International Journal of Low-Carbon Technologies, 18, pp. 1120-1133, 2023.

**[7]. Guascito M. R., Lionetto M. G., Mazzotta F., Conte M., Giordano M. E., Caricato R., Contini D.,** *Characterisation of the correlations between oxidative potential and in vitro biological effects of PM10 at three sites in the central Mediterranean.* Journal of Hazardous Materials, 448, 130872, 2023.

**[8]. Gaman A. N., Simion A., Simion S.,** *Air quality monitoring in the eastern Jiul Valley.* In MATEC Web of Conferences (Vol. 389, p. 00044). EDP Sciences, 2024.

**[9]. Itu R. B., Șoica A.,** *The Reintegration of The Surfaces Affected by the Phenomenon of Subsidence through the Cultivation of Trees with High Energy Value,* Revista De Gestão Social E Ambiental, 18(3), e06506, 2024.

**[10]. Mardani M., Hoseinzadeh S., Garcia D. A.,** *Developing particle-based models to predict solar energy attenuation using long-term daily remote and local measurements.* Journal of Cleaner Production, 434, 139690, 2024.

**[11]. Zheng C., Lu, H., Zhao W.,** *Research of dust removal performance and power output characteristics on photovoltaic panels by longitudinal high-speed airflow,* Energy, 304, 132202, 2024.

**[12]. Khan Y., Bounade C. D.,** *Particulate matter 2.5 air pollution mitigation strategy: the role of green investment, digitalization, and renewable energy in the organization for economic co-operation and development (OECD) countries.* Clean Technologies and Environmental Policy, pp. 1-15, 2024.

**[13]. Haramaini Q., Setiawan A., Sidiq M. H., Brilliawan A. S., Garniwa I.,** *Exploring the Relationship between Solar Panel Adoption and Socio-Economic Factors: A Case Study of Urban Households in Developing Countries.* Journal of Electrical Systems, 20(6s), pp. 2685-2705, 2024.

**[14].** *Bošnjaković M., Santa R., Crnac Z., Bošnjaković T., Environmental Impact of PV power systems.* Sustainability, 15(15), 11888, 2023.

**[15].** National Meteorological Administration, Romania, 2024.

**[16]. Rus C., Lupulescu E., Leba M., Risteiu M.,** *Advanced Mathematical Modeling and Control Strategies for Autonomous Drone Systems.* In 2024 25th International Carpathian Control Conference (ICCC) (pp. 1-6). IEEE, 2024.

**[17]. Rus C., Leba M., Sibisanu R.,** *SOS-My Grandparents: Using the Concepts of IoT, AI and ML for the Detection of Falls in the Elderly,* In World Conference on Information Systems and Technologies (pp. 164-173). Cham: Springer Nature Switzerland, 2024.

**[18]. Rus C., Leba M.,** *Autonomous Smart Electric Vehicle Integrated into a Smart Grid Type System,* In EURECA-PRO Conference on Responsible Consumption and Production (pp. 45-50). Cham: Springer International Publishing, 2022.

**[19]. Rus C., Marcus R., Pellegrini L., Leba M.,** Rebrisoreanu M., Constandoiu A., *Electric cars as environmental monitoring IoT Network.* In IOP conference series: materials science and engineering (Vol. 572, No. 1, p. 012091). IOP Publishing, 2019.

**[20]. Marcus R., Rus C., Leba M., Risteiu M.,** *Electric Vehicles Between Recycling and Sustainable Development-@. ro.* In International Conference on Computers Communications and Control (pp. 47-62). Cham: Springer International Publishing, 2022.

**[21]. Handra A.D., Popescu F.G., Păsculescu D.,** *Utilizarea energiei electrice: lucrări de laborator*, Editura Universitas, 2020.

**[22]. Fîță N.D., Radu S.M., Păsculescu D., Popescu F.G.,** *Using the primary energetic resources or electrical energy as a possible energetical tool or pressure tool*, In International conference KNOWLEDGE-BASED ORGANIZATION, vol. 27, no. 3, pp. 21-26. 2021.

**[23].** **Popescu F.G., Păsculescu D., Păsculescu V.M.,** *Modern methods for analysis and reduction of current and voltage harmonics*, LAP LAMBERT Academic Publishing, ISBN 978-620-0-56941-7, pp. 233, 2020.

**[24].** **Irimie S.I., Radu S.M., Petrilean D.C., Andras A.,** *Reducing the environmental impact of a gas operated cogeneration installation*, MATEC Web Conf. Volume 121, 8th International Conference on Manufacturing Science and Education – MSE "Trends in New Industrial Revolution" Environmental Engineering, 2017.

**[25].** **Vasilescu G.D., Petrilean C.D., Kovacs A., Vasilescu G.V., Pasculescu D., Ilcea G.I., Burduhos-Nergis D.P., Bejinariu C.,** *Methodology for assessing the degree of occupational safety specific to hydrotechnical construction activities, in order to increase their sustainability,* Sustainability, Jan 21;13(3):1105, 2021.

**[26].** **Petrilean D.C., Irimie. S.I.,** *Carrying out and analysing the real and optimum energetic balance of thermal consumers issuing from the outline of the balance SC SEWS Romania SRL Alba Iulia,* Research Scientific Report, University of Petroşani, 2013.

**[27].** **Andras A., Popescu F.D., Radu S.M., Pasculescu D., Brinas I., Radu M.A., Peagu D.,** *Numerical Simulation and modeling of mechano–electro–thermal behavior of electrical contact using comsol multiphysics*. Applied Sciences, 14(10):4026, 2024.

**[28].** **Petrilean D.C.,** *Compresoare eliciodale,* Editura Tehnica-Info, 2006.

**[29].** **Petrilean D.C.,** *Termodinamica tehnica si masini termice*, Editura A.G.I.R., 2010.

**[30].** **Petrilean D.C., Stanilă S., Dosa I.**, *A mathematical model for determining the dimensionless heat flux with application in mine environment,* Environmental Engineering and Management Journal, Vol.16, No. 6, 1249-1414, 2017.

**[31].** **Csaszar T., Pasculescu D., Darie M., Ionescu J., Burian S.,** *Method for assessing energy limited supply sources, designed for use in potentially explosive atmospheres*, Environmental Engineering and Management Journal 11, no. 7, 1281-1285, 2012.

**[32].** **Arad S., Marcu M., Pasculescu D., Petrilean D.C.,** *Aspects of the electric arc furnace control,* Proceeding. of international symposium advanced engineering & applied management, Faculty of Engineering Hunedoara, 2010.

**[33].** **Stepanescu, S., Rehtanz, C., Arad, S., Fotau, I., Marcu, M., Popescu, F**. *Implementation of small water power plants regarding future virtual power plants* 10th International Conference on Environment and Electrical Engineering, pp. 1-4, IEEE, 2011.

**[34].** **Fîță N. D., Lazăr T., Popescu F. G., Pasculescu D., Pupăză C., Grigorie E.**, *400 kV power substation fire and explosion hazard assessment to prevent a power black-out,* International Conference on Electrical, Computer Communications and Mecatronics Engineering-ICECCME, pp. 16-18, 2022.

**[35].** **Fita N.D., Obretenova M.I., Pasculescu D., Tatar A., Popescu F.G., Lazar T.,** *Structure and analysis of the power subsector within the national energy sector on ensuring and stability of energy security*, Annals of „Constantin Brâncuşi" University of Târgu Jiu, ENGINEERING SERIES, Issue 2/2022, pp.177-186, 2022.

**[36].** **Petrilean D.C.**, *Elaborating and Analysing the Real Balance of Heat for the Steam Generator RGL 10/DD* Annals of the University of Petrosani, Mechanical Engineering,Volume 10, 155-160, 2008.

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