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Economic Feasibility of Using Distributed Generation Resources Independently to Supply Energy for Cryptocurrency Miners

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***Abstract*-- In this study, a behavioral analysis was conducted on Distributed Generation (DG) systems to study the feasibility of using them independently and off-grid, to supply energy for cryptocurrency miners by considering economic and technical factors. After conducting a behavioral analysis on Antminer S19 Pro, the results obtained from the performed projects will be used to confirm their technical feasibility. Then, using a small-scale miner farm, MATLAB software will be utilized to prove that although using some DG solutions, such as solar, wind, and diesel, is technically feasible, their costrevenue performance renders them economically unviable. Additionally, this research proves that the interest of companies in utilizing off-grid DGs to provide electricity for cryptocurrency miners is minimal. The simulations applied in this study incorporated cost-revenue modeling, performance degradation factors for PV, diesel generators, and wind systems, and stochastic load profiles for miners to validate the technoeconomic results. These simulations provided quarterly profitability forecasts for each DG configuration.**

***Index Terms*- Cryptocurrency, Distributed Generation (DG), Economic Feasibility, Miner, Technical Feasibility.**

I. Introduction

Nowadays it is inevitable to use electricity for most of daily technical tasks. Among various stages of electric energy cycles from generation to transmission, the distribution stage comes last and directly interacts with the customers or consumers. The objective of the electricity distribution stage is to deliver the energy to the end user by preserving the predetermined criteria and components. Regardless of the type of consumer at the electricity distribution stage (demand-based or non-demand-based), this stage is tasked with providing energy to the end user; however, the electricity generation mechanism has nothing to do with either the transmission, distribution, or even the customer. Since the majority of electricity generation resources are currently comprised of fossil-fueled or hybrid plants, their environmental consequences as well as their drawbacks have attracted attention [1]. On the other hand, the growing demand for electricity and the decrease in fossil fuel reserves highlights the need to replace them with alternative renewable energy resources more than ever [2]. According to the various advantages and drawbacks of renewable energy sources, their performance and deployment mechanisms vary. Currently, one of the most widely used methods for using renewable sources for generating electricity is a DG system, which offers benefits such as proximity of generation plants to the consumers, loss reduction, increased reliability, and so on [3]. Although some DG plants use diesel as fuel, due to the nature of fossil fuels, these generators are usually utilized as backup or in a hybrid configuration [4]. The proximity of DG plants to end users increases system reliability, which is crucial for users who need a stable and constant energy source. Cryptocurrency mining devices (ASIC) are among such users [5], which rely on a stable electricity source for continuous operation. They consume considerable energy to perform heavy computational tasks and facilitate blockchain transactions to obtain cryptocurrency tokens as a reward [6]. When a mining farm consisting of such systems is connected to a distribution grid, regardless of their legal or illegal status, they impose destructive factors on the grid, such as harmonics, imbalances, and ultimately saturating the grid [7]. Therefore, it is crucial to find alternative energy solutions for miners, with DG plants being a good candidate. A study has been conducted on using such systems by allocating generation surplus to power miners [8]. Another research investigated renewable energy sources in an on-grid hybrid configuration to power cryptocurrency miners [9]. In [10], a DC-DC buck converter integrated into a solar generation system was used to provide energy for mining devices, and Arduino software was employed for control and measurement. Another study on the relationship between renewable energy sources and cryptocurrency mining highlights the environmental impacts of using such energy

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sources [11]. It is also important to consider financial matters when deploying such systems to provide electricity for cryptocurrency mining. In [12], an investigation was conducted on a sample microgrid including various consumers such as electric vehicles. This study addresses a notable research gap in the literature, as previous works have often examined renewable or DG-based supply for cryptocurrency mining only in grid-connected or hybrid modes, while the economic and technical feasibility of fully independent DG systems for mining, especially in the context of rapid cryptocurrency market volatility, has not been comprehensively evaluated. This gap is addressed by conducting a comparative techno-economic analysis across multiple DG technologies under off-grid conditions. The central problem investigated in this paper is the lack of reliable, economically viable, and environmentally conscious energy supply options for cryptocurrency miners operating independently from the grid. The motivation stems from the growing global restrictions on crypto-mining grid usage, the environmental impact of fossil-based power, and the opportunity to utilize renewable DG as a sustainable alternative. The following sections discuss the operational characteristics of various DG systems, including photovoltaic, wind, and diesel, and the requirements of establishing a cryptocurrency mining farm.

II. PERFORMANCE OF CRYPTOCURRENCY MINERS

Since the onset of cryptocurrencies and their utilization in world trades, their sources and methods of obtaining them have attracted attention. For this reason, old cryptocurrency mining computers have been replaced by powerful ASIC miners. These devices execute various algorithms through heavy computation to accomplish blockchain transactions and obtain a unit of cryptocurrency tokens as a reward. If these devices are set up as a farm, the time required for processing transactions and obtaining tokens significantly decreases; however, energy consumption also rises considerably and leads to destructive consequences such as harmonics [13]. Regardless of the type of cryptocurrency being mined, whether it is Bitcoin, Ethereum, Ripple, Cardano, Monero, etc., the scale of a farm highly depends on the power of the devices and the return on investment period. Furthermore, as cryptocurrency mining farms expand and become more popular, various side effects like air pollution due to carbon emissions are gaining attention [14]. Now, for modeling and studying the feasibility of mining cryptocurrency using the above-mentioned methods, the characteristics of a small-scale mining farm comprised of 10 Antminer S19 Pro devices will be considered [15]:

$$Antminer\ S19\ Pro: 3250^{w} \times 24^{h} = 78\ KWh/day \quad (1)$$

$$\rightarrow 78^{k} \times 10 \times 30^{days} = 23400 KW/h \quad (2)$$

Based on the above formula, such a farm consumes 23,400 W/h of energy on a monthly basis. Assuming the continuous operation of all devices, the farm yields one Bitcoin every four years. Considering that the price of Bitcoin in December 2024 was €98604 [16], the net monthly revenue from this farm is obtained as €1900. Subsequently, considering the technical requirements, we studied the implementation of this farm using solar, wind, and diesel DG sources.

III. TECHNICAL AND ECONOMIC FEASIBILITY OF USING DG RESOURCES

Several factors influence a DG plant, each considered an independent factor for the construction and operation of a plant. For instance, the fuel price in a country is a decisive economic factor for establishing a diesel DG plant, or for a wind plant, the minimum regional wind speed is considered an important technical factor. Therefore, despite similar requirements for constructing or operating various types of DG plants, each also possesses unique technical, economic, environmental, etc. aspects, which are separately discussed in Fig. 1.

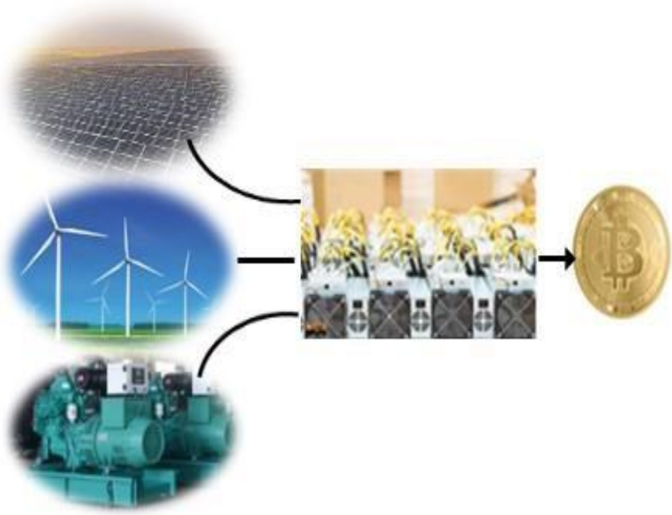

Fig 1. Various energy sources for a cryptocurrency mining farm.

A. Technical and Economic Feasibility of Solar DG Systems

Solar energy is the cheapest and most available energy source in the world, which is widely utilized for various residential and industrial applications. This renewable energy source can be harnessed in most regions of the world at different efficiency levels depending on the geographical location, radiation intensity, radiation duration, types of equipment, etc. Solar DG plants are usually utilized in hybrid or on-grid configurations, irrespective of their components [17]. However, several projects have explored the use of independent solar DG plants to power various types of consumers. By considering the behavior of cryptocurrency miners and including other equipment, such as solar panels and batteries (beyond the energy demands of the proposed farm), these projects have demonstrated the technical feasibility of using them for mining purposes [18–20].

Since the construction and operation of DG plants are one of the most important aspects of investing in the energy sector, financial issues significantly impact their types and scales. Most costs are associated with purchasing equipment such as batteries, solar panels, and inverters, which have various prices worldwide. Since the cost of implementing and establishing such systems differs worldwide, only the most important aspect, purchasing equipment, will be discussed. The largest share of equipment cost in constructing photovoltaic power plants is attributed to purchasing batteries and is proportional to the number of batteries required.

It should be noted that compared to independent solar DG plants, on-grid ones perform significantly better in terms of revenue; however, this factor has not been considered in this research [21]. For simplicity, we chose the Euro as the basic currency for calculating costs and revenues and obtaining a general perspective. Each of the above-mentioned miners costs €1050 [22], leading to the following calculation for the farm:

$$total\ cost\ of\ miners: 1050 \times 10 = 10500€ \quad (3)$$

Since this research addresses independent or off-grid DG, no cost has been considered for purchasing electricity from the grid, and only the equipment costs are taken into account. The requirements include 450 square meters of land area, seventy 550W solar panels, batteries, and an inverter [23-25]. Excluding the land price, we have:

$$cost\ of\ panels: 70 \times 650^{€} = 45500€ \quad (4)$$

Now, by adding the cost of a 40KW inverter and 25 batteries, we have:

$$cost\ of: 25^{storage} + inverter\ 40Kw \Rightarrow 13500€ \quad (5)$$

Therefore, the total costs of the above items plus the cables, sockets, and structure required for 20 years amount to:

$$total\ cost\ of\ solar\ DG: 73000€$$

The total cost has been calculated for a power yield beyond the farm's consumption to ensure uninterrupted performance during potential maintenance and overhaul procedures. Additionally, due to the very low cost of repair and maintenance procedures associated with photovoltaic power plants, only 1% of the total costs are allocated for maintenance and repair. Therefore, according to the simulation results of cryptocurrency mining's initial cost and revenues, illustrated in Fig. 2, are presented every quarter:

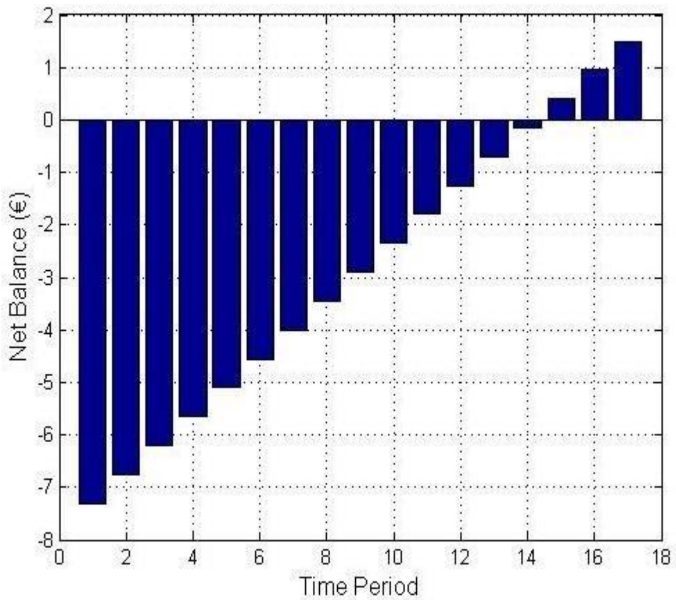

Fig 2. Cost and revenue chart (on a quarterly basis)

According to the chart, the independently implemented mining system becomes profitable after 39 months of continuous operation. However, this period can be shortened by minimizing equipment costs to the exact needs of the mining operation, which may compromise energy stability and mining continuity, so an additional energy source is also required. Overall, even considering the rising price of Bitcoin and assuming no changes in the proposed energy generation system, this plan is not economically viable and provides little incentive for investment in such independent mining systems. It should be noted that the growing adoption of ongrid solar power generation systems for cryptocurrency mining has led to increased environmental concerns, which require more thorough long-term studies [26].

B. *Technical and Economic Feasibility of Wind-based DG systems*

Wind-based DG systems are typically deployed in locations that experience strong winds, such as coastal areas and foothills. Wind turbines are set up in large numbers in a wind farm configuration to increase efficiency and grid reliability. Regardless of the type of turbines used in wind farms or other equipment like converters, gearboxes, etc., the output of the farms or individual turbines is designed to match the type and scale of the consumers, a factor always considered during the design phase. In this generation system, wind speed is always a critical challenge. To address this challenge, transformer controllers can be used to obtain an output with minimum fluctuations [27]. Wind-based generation systems are generally divided into off-shore and on-shore categories. China, the United States, and Germany are the leading countries in terms of wind-based energy generation, responsible for roughly two-thirds of global wind-based energy production by annually generating 51.3 GW of electricity [28]. Considering various completed wind farm projects, it is technically feasible to use the energy generated to power cryptocurrency miners, provided appropriate adjustments are made [29-31]. However, numerous factors, such as harmonics, variable wind speeds, and frequency fluctuations, can also be assessed in wind farms. To address the harmonics issue, specific methods and algorithms have been developed and implemented [32, 33].

In wind farms, the placement of turbines significantly impacts the environmental and economic factors, highlighting the importance of maximizing their power generation efficiency. The average cost of connecting mining sites to an on-shore wind farm is nearly €670, while it is several times more expensive for an off-shore wind farm. Based on a mining site's energy consumption, for a medium-scale wind farm consisting of HAWTs with a capacity of 40KW power generation, we have [34-37]:

$$cost\ of\ wind\ farm + storage + links: 48500€$$

Based on the nature of HAWTs and the maintenance procedures required during their 20-year operational lifespan, additional expenses are included as follows:

$$total\ operation\ and\ maintenance\ costs: maintenance\ cost + spare\ parts\ cost \Rightarrow 30500€^{20years}$$

$$\rightarrow total\ cost: 48500 + 10500 = 59000€ \quad (6)$$

The result indicates the total cost in 20 years. Since the mining site must stay operational continuously, the calculated cost of equipment and maintenance exceeds the required capacity. It must be noted that some expenditures, such as insurance costs, transportation costs, etc., were excluded due to their uncertainty and variability in different countries. By considering annual maintenance, the resulting initial cost and mining revenue every quarter are obtained as illustrated in Fig. 3:

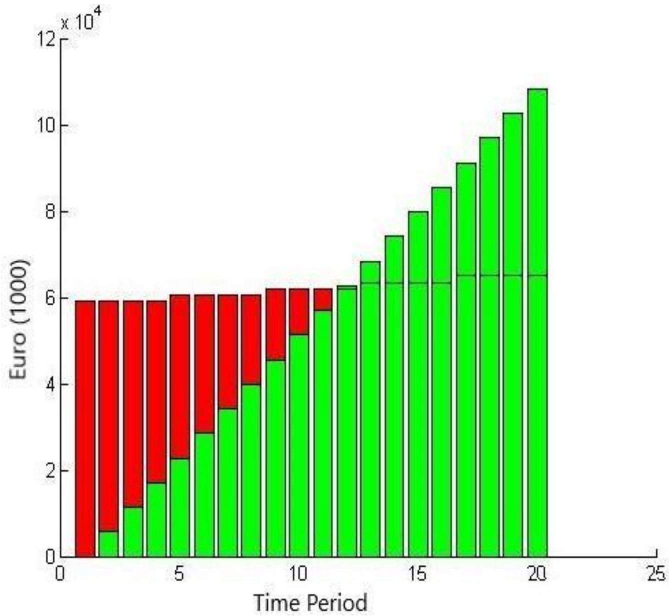

Fig 3. Cost and revenue chart (quarterly)

In the provided bar chart, costs and revenue are represented in red and green, respectively. The annual maintenance cost is also included in the chart. Assuming revenue withdrawals every three months, this system will become profitable after 33 months of continuous operation. Notably, the equipment and other related costs are calculated based on a power generation capacity exceeding the mining site's requirement, so the profitability period can be mitigated by removing the excess costs, in exchange for a heightened risk of power stability failure. It is noteworthy that off-shore wind turbines are becoming more popular nowadays, and so are their potential failure occurrences and their environmental consequences [38].

C. Technical and Economic Feasibility of Diesel DG Systems

Diesel DG systems are among the earliest electricity generation sources widely used in small-scale or alternative power plants, and their most common application is peak load reduction. Compared to solar and wind-based, diesel DG systems are easier to deploy and operate; however, due to their dependency on fuel, they always struggle with challenges such as fuel storage and emissions. Regardless of their components, such as controllers, CAN buses, flywheels, etc., large-scale diesel generators are not common and are more commonly set up on smaller scales, such as below 3000KVA. Nowadays, due to high emissions and fuel costs, these systems are less common and face strict regulations by the authorities [39]. However, their faster construction and relative simplicity make diesel generators an appealing option for enhancing network reliability and improving load response speed in many systems [40, 41]. Since large-scale diesel DGs are not commonly used, as an alternative, paralleled small-scale diesel DG systems can be used to generate large-scale amounts of energy, indicating their capability to be utilized as an energy source for mining farms.

As previously mentioned, the issues of fuel procurement and storage for these energy generation systems are critical, making fuel transportation costs a significant factor as well [42]. Therefore, the distance between fuel supply points and diesel DG plants is initially investigated before construction and operation. To supply energy for our mining farm, several paralleled diesel generators with a total capacity of 50KVA will now be studied. Similar to previous cases, the total capacity of the generation system will exceed the capacity required for the mining farm to ensure continuous work. Hence, the total costs are calculated as below [43-47]:

$$diesel\ generator\ startup\ cost: 5500€^{cables\ldots} + 18000€_{generators} + 6000_{installation} = 29500€ \rightarrow +10500^{€} = 40000€ \quad (7)$$

Considering the output power of the diesel plant and assuming an 80% load utilization, we will have:

$$fuel\ consumption: 12\ {}^{L}/h$$

Considering the average diesel generator fuel price of €1.55 per liter in December 2024, we will have:

$$fuel\ cost: 12 \times 1.55 = 18.6\ {}^{€}/h \quad (8)$$

$$\rightarrow 8760 \times 18.6 \simeq 163000\ {}^{€}/year \quad (9)$$

Given the above 30,000 hours expected lifespan of diesel generators before requiring periodic maintenance, assuming ideal conditions such as proper ventilation, high-quality fuel, etc., the maintenance and part replacement (for example, filters) costs of a diesel power plant are estimated at €4000 per year. Considering the continuous operation of diesel generators and the monthly mining revenue, profitability is unattainable due to high fuel costs.

IV. COMPARISON

The power generation methods were evaluated, and costrevenue results were obtained, indicating the economic viability of each method. Table I presents a summary of profitability and economic aspects to allow a comparison between various factors affecting the economic viability.

TABLE I
Expenditures and Profitability Period of Various System (€).

Factors / DG	Revenue (Quarterly)	Total Initial Costs	Repair and Maintenance Costs	Fuel Costs	Profitability Period
PV	5700	73000	7,000 (20years)	-	In 39 months
Wind	5700	59000	30,500 (20years)	-	In 33 months
Diesel Generator	5700	40000	4,000 (Annual)	163,000 (Annual)	-Null-

According to Table I, the initial construction and deployment costs for diesel generation plants are significantly less than those of other systems; however, they are not economically viable due to high fuel costs. Although the maintenance of wind-based plants costs more than solar plants, due to their lower initial costs and higher efficiency, using them as independent DG systems to supply cryptocurrency miners is more economically viable. It should be noted that only the main costs have been considered in evaluations, and some other expenditures, such as land, human force, monitoring, etc., have been excluded due to the lack of uniform global pricing. It is also noteworthy that energy generation systems have been evaluated independently. However, recent approaches include hybrid power generation that mitigates various challenges associated with each generation system, highly affecting the profitability period. In addition to the independent DG options, a brief review of hybrid configurations (e.g., PV–Wind, PV–Diesel) from the literature has been included. Preliminary simulations from previous studies indicate that such hybrid systems can achieve shorter payback periods and improved supply stability compared to single-source DG systems. However, a complete techno-economic analysis of these configurations was considered beyond the scope of this paper and is suggested as a promising direction for future work.

V. CONCLUSION

While the payback period for solar systems in this study exceeded three years, it is important to note that strategic sizing of generation capacity relative to the miner load, and integration of hybrid sources, could significantly improve economic outcomes. Furthermore, in contexts where grid use for mining is legally restricted, independent renewable DG systems may still present a compelling long-term investment despite higher initial costs. The analysis in this paper assumes average December 2024 cryptocurrency prices and constant miner efficiency. In practice, uncertainty in production (due to renewable variability), fluctuations in cryptocurrency prices, and differences in miner capacity can substantially alter the profitability timeline. Sensitivity analyses considering ±30% price variation and ±20% production deviation indicate that profitability periods could shift by over one year. The presented methodology remains applicable by updating economic parameters and load assumptions as market conditions change. From a technical perspective, the study evaluated each DG type under realistic operational constraints, including maintenance cycles, capacity factors, and redundancy requirements. Future work will expand these simulations to include detailed electrical models, harmonic analysis, and integration with storage systems to further align with engineering practice. Now, based on the analysis conducted for a sample mining farm, each distributed generation system was first evaluated technically. According to the conveyed projects, the technical feasibility of their independent use for mining was confirmed. Subsequently, the profitability of each system was individually analyzed for the sample farm, and all significant economic factors were calculated using the average prices of December 2024, and their respective cost-revenue bar charts were obtained. According to the results, it was evident that although the initial costs and maintenance costs varied among different generation systems, the profitability period was significantly long for all three systems. In conclusion, neither of the power generation plants studied was economically viable for cryptocurrency mining. However, it was proven that despite their higher maintenance costs, wind-based systems perform better in terms of economic viability, because their profitability period is lower than that of diesel and solar DG plants.

REFERENCES

[1] M. Beken, N. Kurt, and O. Eyecioglu, "Estimating the Effect of Renewable Energy Policies on the Republic of Turkey's Gross National Product by using Artificial Intelligence," 2022 11th International Conference on Renewable Energy Research and Application (ICRERA), Istanbul, Turkey, 2022, pp. 606-610.

[2] R. Pasangkunan, Yusran, and F. Mayasari, "Techno-Economic Analysis of Hybrid Power Generation System for Off-Grid Electricity System at Karanrang Island," 2024 4th International Conference on Electronic and Electrical Engineering and Intelligent System (ICE3IS), Yogyakarta, Indonesia, 2024, pp. 93-98.

[3] E. E. E. Ahmed and G. Poyrazoglu, "Optimizing Distributed Generation Sizing and Siting using Particle Swarm Optimization: A Comparative Study," 2023 IEEE International Conference on Environment and Electrical Engineering and 2023 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), Madrid, Spain, 2023, pp. 1-5.

[4] J. Fernandes, V. Patil, M. Manyar, B. Patil, and N. Joshi, "Analysis of Hybrid Distributed Generation System Using HOMER," 2024 Second International Conference on Smart Technologies for Power and Renewable Energy (SPECon), Ernakulam, India, 2024, pp. 1-5.

[5] Z. Liu et al., "Bitcoin Mining Recognition Based on Community Detection with Electricity Consumption Data," 2021 IEEE 5th Conference on Energy Internet and Energy System Integration (EI2), Taiyuan, China, 2021, pp. 3091-3096.

[6] A. Sajjad, Q. Zhang, F. Ciampi, F. Pascucci, and B. Gupta, "What Motivates Bitcoin Miners to Practice Bitcoin Mining: An Assessment Based on Behavioral Reasoning Theory," in IEEE Transactions on Engineering Management, vol. 71, pp. 8209-8222, 2024.

[7] J. B. Noshahr, M. Bagheri, and M. Kermani, "The Estimation of the Influence of Each Harmonic Component in Load Unbalance of Distribution Transformers in Harmonic Loading Condition," 2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), 2019, pp. 1-6.

[8] Mehran Hajiaghapour-Moghimi, Ehsan Hajipour, Kamyar Azimi Hosseini, Mehdi Vakilian, Matti Lehtonen, Cryptocurrency mining as a novel virtual energy storage system in islanded and grid-connected microgrids, International Journal of Electrical Power & Energy Systems, Volume 158, 2024.

[9] M. Hojjat and M. H. Kalali, "Techno-economic analysis of a gridconnected hybrid PV power plant integrated with a crypto currency mining system," 2021 11th Smart Grid Conference (SGC), Tabriz, Iran, Islamic Republic of, 2021, pp. 1-6.

[10] P. Rorich, K. Moloi, T. F. Mazibuko, and D. J. Reddy, "Cryptocurrency Mining Powered by Solar Energy Using a DC-DC Connection with IoT Control," 2024 IEEE PES/IAS PowerAfrica, Johannesburg, South Africa, 2024, pp. 1-5.

[11] Miśkiewicz, Radosław, Krzysztof Matan, and Jakub Karnowski. 2022. "The Role of Crypto Trading in the Economy, Renewable Energy Consumption and Ecological Degradation" Energies 15, no. 10: 3805.

[12] P. Rezaei and M. A. Golkar, "Two-Stage Energy Management System of Microgrid in the Presence of Cryptocurrency Mining Farms," 2023 13th Smart Grid Conference (SGC), Tehran, Iran, Islamic Republic of, 2023, pp. 1-6.

[13] A. -S. Es'haghi, E. Afjei, A. Marini, and M. Karimi, "Detection of Illegal Cryptocurrency Mining Farms in Distribution Systems Using Harmonic State Estimation," 2023 13th Smart Grid Conference (SGC), Tehran, Iran, Islamic Republic of, 2023, pp. 1-6.

[14] Shali Tayebi, Heresh Amini, The flip side of the coin: Exploring the environmental and health impacts of proof-of-work cryptocurrency mining, Environmental Research, Volume 252, Part 1, 2024.

[15] A. Rouhanian, M. Ghafari, G. B. Gharehpetian, R. Asaadi, M. Azimpour, and M. S. Naderi, "Supplying a Bitcoin Mining Farm by Maximum Utilization of Renewable Energy Sources in Microgrid," 2024 28th International Electrical Power Distribution Conference (EPDC), Zanjan, Iran, Islamic Republic of, 2024, pp. 1-7.

[16] https://coinmarketcap.com/currencies/bitcoin/

[17] R. Hrbac, V. Kolar, S. Kocman, L. Demel, L. Hrdina, and K. Slany, "Analysis of Power Flows in a Building With Non-Linear Loads and a Hybrid Photovoltaic Power Plant With Battery Storage," 2024 24th International Scientific Conference on Electric Power Engineering (EPE), Kouty nad Desnou, Czech Republic, 2024, pp. 1-5.

[18] M. Linca, I. Popa, C. V. Suru, and F. Ravigan, "Comparative Analysis of Performances of Photovoltaic Power Plants," 2023 International Conference on Electromechanical and Energy Systems (SIELMEN), Craiova, Romania, 2023, pp. 1-6.

[19] August Bruno, Paige Weber, Andrew J. Yates, Can Bitcoin mining increase renewable electricity capacity? Resource and Energy Economics, Volume 74, 2023.

[20] Y. Liang et al., "Sustainable Energy-based Cryptocurrency Mining," 2022 IEEE PES Innovative Smart Grid Technologies - Asia (ISGT Asia), Singapore, Singapore, 2022, pp. 789-793.

[21] B. Eid, M. R. Islam, A. -A. Nahid, A. Z. Kouzani and M. A. Parvez Mahmud, "Improving Return on Investment for Photovoltaic Plants by Deploying Customized Load," 2020 IEEE International Conference on Applied Superconductivity and Electromagnetic Devices (ASEMD), Tianjin, China, 2020, pp. 1-2.

[22] https://www.amazon.com/Antminer-S19-pro-110th-Bitmain/dp/B08K7CVKDZ

[23] https://www.energysage.com/local-data/solar-panel-cost/

[24] https://www.solarchoice.net.au/solar-panels/solar-power-systemprices/

[25] https://www.solar.com/learn/solar-panel-cost/

[26] McDonald, Matthew & Hayibo, Koami Soulemane & Hafting, Finn & Pearce, Joshua. (2023). Economics of Open-Source Solar Photovoltaic Powered Cryptocurrency Mining. Ledger. 8. 10.5195/ledger.2023.278.

[27] Y. Chen, M. Chen, Y. Liu, and L. Chen, "Analysing the Voltage Unbalance Impact of Wind Farm on Traction Power Supply System," 2019 14th IEEE Conference on Industrial Electronics and Applications (ICIEA), 2019, pp. 1557-1561.

[28] A. Sánchez-Aguiar, E. Álvarez Rodríguez, A. Santos Fuentefría, O. Rodriguez-Reyes and H. Luis Riccomi, "Analysis of Gibara 1 Wind Farm from 2015 to 2019," 2020 IEEE PES Transmission & Distribution Conference and Exhibition - Latin America (T&D LA), Montevideo, Uruguay, 2020, pp. 1-6.

[29] M. Alzgool and S. Ghannam, "Assessment of an Offshore Wind Farm Potential in the Gulf of Aqaba," 2022 International Engineering Conference on Electrical, Energy, and Artificial Intelligence (EICEEAI), Zarqa, Jordan, 2022, pp. 1-7.

[30] Carlos L. Bastian-Pinto, Felipe V. de S. Araujo, Luiz E. Brandão, Leonardo L. Gomes, Hedging renewable energy investments with Bitcoin mining, Renewable and Sustainable Energy Reviews, Volume 138,2021.

[31] Raúl Vega-Marcos, Antonio Colmenar-Santos, Francisco Mur-Pérez, Clara Pérez-Molina, Enrique Rosales-Asensio, Study on the economics of wind energy through cryptocurrency, Energy Reports, Volume 8, Supplement 15,2022, Pages 970-979.

[32] Z. Yang, Y. Wen, S. Ye, Q. Guo and L. Zhao, "Data Analysis of Abnormal Harmonic of Offshore Wind Farm," 2023 IEEE 2nd International Conference on Electrical Engineering, Big Data and Algorithms (EEBDA), Changchun, China, 2023, pp. 307-312.

[33] X. Wang, L. Chen, H. Li, W. Chen, F. Jiang, and M. Chen, "Equivalent Wind Farm Model Considering Different Wind Speeds and Wake Effects," 2023 6th International Conference on Electrical Engineering and Green Energy (CEEGE), Grimstad, Norway, 2023, pp. 287-291.

[34] C. Ma, L. Qi, Y. Wang, S. Zhang, Y. Li and S. Jia, "Genetic Algorithm Based Whole Life Cycle Cost Prediction Model for Wind Farms," 2023 IEEE 7th Conference on Energy Internet and Energy System Integration (EI2), Hangzhou, China, 2023, pp. 429-433.

[35] X. Zhang, X. Wu, Y. Li, Y. Wang, Y. Zhang, and Y. Li, "Levelized Cost of Energy Modeling of Wind Farms Based on Wind Turbine Reliability," 2023 IEEE 7th Conference on Energy Internet and Energy System Integration (EI2), Hangzhou, China, 2023, pp. 1721-1726.

[36] https://www.renewableenergyhub.co.uk/main/wind-turbines/howmuch-does-a-wind-turbine-cost

[37] Yang Li, Bo Feng, Bin Wang, Shuchao Sun, Joint planning of distributed generations and energy storage in active distribution networks: A Bi-Level programming approach, Energy, Volume 245, 2022.

[38] A. Oliveira et al., "Simulation Environment for UAV Offshore WindTurbine Inspection," OCEANS 2023 - Limerick, Limerick, Ireland, 2023, pp. 1-6.

[39] Hossein Shayeghi, Masoud Alilou, 3 - Distributed generation and microgrids, Editor(s): Ersan Kabalci, Hybrid Renewable Energy Systems and Microgrids, Academic Press, 2021, Pages 73-102.

[40] D. Qiu et al., "The Development of a Power System of the Combination of Diesel Generator and UPS," 2019 10th International Conference on Power Electronics and ECCE Asia (ICPE 2019 - ECCE Asia), Busan, Korea (South), 2019, pp. 2706-2709.

[41] T. Bragatto et al., "Emergency Generators for Supplying Islanded MV Networks," 2022 AEIT International Annual Conference (AEIT), Rome, Italy, 2022, pp. 1-6.

[42] D. C. Huynh, L. D. Ho, M. W. Dunnigan, and C. Barbalata, "Optimal Operation of a Microgrid by Planning Diesel Generators and Microturbines," 2023 International Conference on Signal Processing, Computation, Electronics, Power and Telecommunication (IConSCEPT), Karaikal, India, 2023, pp. 1-6.

[43] Shchasiana Arhun, Aleksandr Bogajevskiy, Andrii Hnatov, Nadezhda Kunicina, Improving the efficiency of frequency regulation for HighPower diesel generators, Energy Conversion and Management: X, Volume 24, 2024.

[44] https://target-generators.com/cost-of-industrial-diesel-generators

[45] Chhunheng Lao, Supachart Chungpaibulpatana, Techno-economic analysis of hybrid system for rural electrification in Cambodia, Energy Procedia, Volume 138,2017, Pages 524-529.

[46] https://www.eia.gov/petroleum

[47] Theophilus-Johnson, Kombo & Nwaorgu, Godspower & Tamunodukobipi, Daniel. (2020). Service Lifespan Cost Analysis of a Marine Auxiliary Generator Using Manufacturer's Manual.