SUSTAINABLE BITCOIN MINING

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A B S T R A C T

Bitcoin, as a digital payment asset, has brought about a kind of revolution in the global market. Despite its numerous economic benefits, bitcoin mining has a significant negative impact on the environment due to its high electricity consumption during the mining process. With this in mind, the study analyzed the profitability of using green energy, specifically solar energy, for bitcoin mining. Based on the movement of Bitcoin's value over the past 50 months, a comparison was made between the profitability of bitcoin mining using energy from non-renewable and renewable (green) sources. Subsequently, a minimum Bitcoin value was determined at which it becomes necessary to cease further green mining and instead commence the production and sale of solar energy to the utility company. The research also demonstrated that greater profit is achieved solely through supplying solar energy compared to green bitcoin mining.

Introduction

Economic development offers many positive benefits, such as improving living standards and developing new technologies that make life easier. However, most of these advantages have a negative impact on the environment. In the 20th century, the need to align economic development with environmental preservation was recognized

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to prevent disruptions in biodiversity on Earth. It became necessary to establish rules and laws for countries to plan their future development with the goal of environmental conservation. From this idea emerged the concept of sustainable development.

Traditional centralized banking systems often did not provide individuals with significant privacy or the opportunity to achieve financial freedom. The development of new technologies prompted developers to consider creating a digital decentralized value system that could potentially replace traditional banking systems in the future. The development of blockchain technology led to the creation of the first crypto currency called Bitcoin. Today, Bitcoin is considered digital gold and is used worldwide for conducting transactions and purchasing goods and services. However, the biggest criticism of Bitcoin's existence and operation is its significant energy consumption for "mining." This is one of the main reasons why Bitcoin has not yet been widely accepted globally as an official means of payment. The issue of high energy consumption in Bitcoin production can be addressed through "green mining," i.e., using energy from renewable sources for its mining operations.

The subject of this research is green bitcoin mining, the production, and use of solar energy as a renewable energy source (RES) for its mining, aimed at environmental preservation.

The objective of the research is to analyze the profitability of bitcoin mining using renewable energy sources (RES) and to determine the minimum bitcoin price at which selling green energy becomes more profitable compared to green bitcoin mining.

The study utilized specialized literature and all available data related to the concept of sustainable development, as well as information on Bitcoin and blockchain technology. In addition to scholarly literature, official data sources were used regarding the movement of Bitcoin and gold prices, including various credible websites interpreting the data.

The authors will establish the profitability of bitcoin mining using green energy - specifically solar energy - in the course of the research. Profitability will be determined using basic investment indicators such as annual return on investment and payback period. The marginal cost of green bitcoin mining, i.e., the lowest cost at which green bitcoin mining becomes profitable, will also be determined. Following this, the profitability of producing and selling solar energy will be assessed by comparison with the results of green bitcoin mining.

Materials and methods

When determining the cost of building a solar power plant, data from the company "MT Komex" specializing in solar power plant construction were used. For the purposes of green bitcoin mining, a solar power plant with a capacity of 56 kW is required. The construction cost of this power plant amounts to $180,351 USD. The profitability of investing in green bitcoin mining largely depends on the profitability of the mining machine itself. The annual profit was determined based on the median price of Bitcoin

during the last cycle (January 1, 2020, to March 1, 2024), which amounted to $31,198 USD. In addition to basic indicators such as investment cost and the profitability of the bitcoin mining machine, consideration must also be given to the annual return on investment (ROI) and payback period (PBP). The annual return on investment (ROI) is determined as follows (Gogić, 2014):

$$ROI = \frac{Annual\ return\ on\ investment}{Cost\ of\ investment} * 100$$

In addition to ROI, another important indicator is the payback period of investment (PBP). Many investors consider this indicator as one of the main metrics of investment viability. The payback period of investment is determined as follows (Gogić, 2014):

$$PBP = \frac{Cost\ of\ investment}{Annual\ return\ of\ investment}$$

The Payback Period of Investment (PBP) represents the number of years required for the invested funds to be recovered and is considered one of the more significant indicators to consider when starting an investment. Based on formulas 1 and 2, it follows that PBP is inversely proportional to ROI (Return on Investment), meaning that a higher ROI results in a shorter PBP.

When calculating the costs of electricity consumption, it's important to consider the expenses incurred from mining during the night when the solar power plant isn't generating electricity. According to data from "MT Komex," the solar power plant can produce electricity for an average of about 18 hours per day, while for the remaining 6 hours, electricity would need to be sourced from the grid, incurring costs for the investor. For the calculation of electricity costs, a lower tariff of $0.0159 USD per kWh was used. To determine the profitability of producing and selling green energy, the feed-in tariff in the Republic of Serbia was considered, which amounts to $0.17 USD per kWh of delivered electricity[5]. According to the Energy Law[6], a 56 kW solar power plant is classified as a small solar power plant.

Additionally, for calculating certain performance metrics in the research, descriptive and comparative methods will be employed, along with mathematical and statistical methods.

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5   Uredba o tržišnoj premiji i fid-in tarifi. *"Službeni glasnik RS",br. 45/2023-11, br. 90/2024-3 dr. uredba, Beograd. https://pravno-informacioni-sistem.rs/eli/rep/sgrs/vlada/uredba/2023/45/3/reg*

6   Zakon o energetici. *"Službeni glasnik RS", br. 145/2014, 95/2018 - dr. zakon, 40/2021, 35/2023 - dr. zakon, 62/2023.,* Beograd. https://pravno-informacioni-sistem.rs/eli/rep/sgrs/skupstina/zakon/2014/145/1/reg

The concept and importance of sustainable development

The concept of sustainability dates back long before the concept of sustainable development. Many theoreticians were interested in the concept of sustainability because they realized that the progress of society and the development of new technologies cannot be sustainable in the long term. Some early theorists proposed that zero economic and population growth might be necessary to ensure long term sustainability. After the Second World War, there was an accelerated development of almost all world economies, and the greatest importance is attached to scientific and technological progress, which was considered to be unlimited. However, various unexpected events, such as the oil crisis from the 1970s have shown that scientific and technological progress is very limited and that economic growth cannot rest solely on it. The rapid development of agriculture and all industrial branches has led many theoreticians to think about the impact of economic growth and development on the environment.

The concept of sustainable development is not easy to define, because it represents "living matter" that is constantly changing, supplementing and innovating. Also, some criteria used to define the concept of sustainable development are difficult to measure, which is another obstacle when making the final definition. Throughout history, many theoreticians have tried to define the concept of sustainable development, however, that definition was never complete for the previously mentioned reasons. A generally accepted definition that is most used today is the definition of the Brundtland Commission from 1987, which states that sustainable development is the development that satisfies the present needs, without jeopardizing the ability of future generations to meet their own needs (WCED, 1987). Pešić (2020) defines sustainability as an essential prerequisite, but also as the ultimate goal of the efficient organization of numerous human activities on Earth. Derlukiewicz et al., (2020) see sustainable development as a strategic trend that unites socio-economic development and global environmental protection. According to (Emas, 2015), the general goal of sustainable development is the achievement of ecological stability, which is achievable through the integration and appreciation of economic, social and ecological aspects in the decision-making process. Sustainability has a wide application in various disciplines such as agricultural production, business operations, urban development and represents the conceptual basis for the principles of green and circular economy (Ruggerio, 2021).

Sustainable development is a multidimensional concept that includes three different segments: (1) economic, (2) social and (3) environmental. In other words, progress in one dimension depends on achievement in the other two (Stevens, 2011). Economic productivity, for example, will be impaired if there is an imbalance in the social and environmental segments. Effective implementation of this concept implies defining and achieving various goals of sustainable development. During 2015, the General Assembly of the United Nations defined a total of 17 goals, which essentially represent the concretization of the mentioned dimensions (Bargier & Burgess, 2017). Each of the goals should have the following specificities: (1) be precisely defined, (2) measurable, (3) achievable, (4) realistic, (5) and time-bound

(Jovanović Gavrilović, 2008). Achieving goals implies coordination of various activities of participants and stakeholders (inhabitants, companies, organizations), and the necessary institutional support.

In this regard, we distinguish between ecological, social and economic goals of sustainable development. For example, the economic goal implies achieving economic growth without increasing inflation and increasing foreign debts. Social means reducing and completely eliminating poverty, as well as reducing social exclusion and solving all kinds of social problems. The ecological goal refers to spreading awareness of the importance of environmental preservation and achieving sustainability in the use of natural resources with emphasis on the increasing use of renewable energy sources (Pešić, 2020). Sachs et al. (2018) created the SDG index (Sustainable Development Goals – SDG) in order to monitor the implementation and achievement of overall sustainability in different countries in the world. This unique indicator enables simpler definition of priority areas for actions, and facilitates global comparison and benchmarking of economies (Fonseka et al., 2020).

In general, the long-term concept of sustainable development implies constant economic growth that ensures poverty reduction, better management of resources, improvement of health conditions and quality of life, reduction of pollution and preservation of biodiversity. Sustainability as such is based on education, Research and development (R&D), digital society and low-carbon economy, contributes to higher employment on the one hand, and a more equal social position of different groups on the other.

Solar energy as a renewable energy source

There are several different classifications of natural resources in the literature, but one generally accepted classification involves the division of resources into renewable resources and non-renewable resources (Pešić, 2012). Non-renewable sources of energy can include various mineral resources such as metals and non-metals, crude oil, natural gas and others. High level of economic growth leads to high level in consumption of non renewable energy and *vice versa* (Salim et al., 2014). In another words, non renewable sources remain the main driving force behind industrial output and real GDP growth. For example, electricity is produced using coal in a large number of countries[7], which has a pronounced negative effect on the environment and climate change issues.

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7   For example, in Serbia around 70% of electricity is obtained from the coal in thermal power plants (source: www.eps.rs, 3.6.2025.)

In particular, the accumulation of ash produced by burning coal in thermal power plants leads to soil degradation, air pollution, negative impact on human health and a large carbon footprint[8] in the form of greenhouse gas (GHG) emissions.

As previously stated, one of the goals of sustainable development is achieving sustainability in the use of natural resources as well as the transition to the use of renewable energy sources (RES). The term renewable energy sources (RES) is associated with the fact that the rate of consumption of these resources does not exceed the rate of their creation. Renewable resources can be divided into natural biological funds, such as fish in open water or forests, and energy flows such as solar energy, wind energy, tides, etc. (Pešić, 2012). Also, RES include hydropower, geothermal energy and biomass. Some authors (Goodstein, 2003) believe that three renewable resources have the greatest potential: solar, hydropower and wind energy.

The use of RES is significant for several reasons. First, greater use of renewable resources can have positive economic effects in the form of an increase in gross domestic product (GDP) (Radmehr et al., 2021). In this regard, one of the prerequisites for use is investment in infrastructure and necessary equipment, which further encourages the growth of employment and innovation activities. Second, renewable sources reduce environmental devastation (Majeed & Luni, 2019). Third but not least, renewable resources reduce pollution and greenhouse effects (Hatefi & Torabi, 2010). In other words, RES can be seen as an option or a mechanism for mitigating climate change.

The main limitations of these resources are reflected in the lack of continuity, since wind and sun do not always realize their full potential (Goodstein, 2003). In addition, from the aspect of production, a smaller amount of energy is accumulated from alternative sources than from non-renewable ones, which suggests a balanced use of both categories of resources (Harris, 2009).

Greater use of RES in overall energy production is important for several reasons. First, they emit zero or minimal CO_2 into the atmosphere. Second, a greater share of RES in total energy increases the energy stability of a country's electrical energy system. And thirdly, by lowering the installation costs of systems for the production of energy from renewable sources, it can be expected that RES will become economically competitive source of energy, especially solar energy, wind energy and biomass energy.

Energy in its various forms is an indispensable factor for economic growth and development in every country, regardless of its level of development. Worldwide, numerous studies examine the impact of energy on national and global economies. A

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8   The total quantity of carbon dioxide (CO_2) released by an activity, either directly, indirectly, or cumulatively, during the course of a product's life cycle is referred to as its "carbon footprint" (goods and services). This includes activities made by individuals, groups of individuals, governments, organizations, procedures, various industries, and so forth. To account for the differing impacts of other greenhouse gases on global warming, it is represented in grams of CO_2 equivalent per kilowatt-hour of generation (gCO_2 eq/Kwh) (Rai et al., 2025).

connection has been established between energy, economy, and ecology (known as the "3E"). Accelerated economic development is based on increased use of energy from conventional sources, leading to heightened greenhouse gas (GHG) emissions and environmental pollution. Due to a lack of understanding of resource characteristics (inexhaustibility), it was once believed that humans could utilize all resources in unlimited quantities. There was even a belief that nature could naturally neutralize waste generated by human activity (Stern, 2010). Energy in its various forms is an indispensable factor for economic growth and development in every country, regardless of its level of development. Worldwide, numerous studies examine the impact of energy on national and global economies. A connection has been established between energy, economy, and ecology (known as the "3E"). Accelerated economic development is based on increased use of energy from conventional sources, leading to heightened greenhouse gas (GHG) emissions and environmental pollution. Due to a lack of understanding of resource characteristics (inexhaustibility), it was once believed that humans could utilize all resources in unlimited quantities. There was even a belief that nature could naturally neutralize waste generated by human activity (Stern, 2010).

Solar radiation reaching the Earth's surface depends on the angle at which solar rays strike, climatic conditions, and terrain. The incident angle at which solar rays hit the Earth is determined by the season and the geographical latitude of the location. Due to Earth's atmospheric pollution with particles, solar rays passing through the atmosphere are scattered and reflected off particles, reducing the amount of solar energy reaching the Earth. The lower the incident angle of the solar rays (closer to the poles), the longer the path of the solar rays, and the greater the scattering (Energy Efficiency & Renewable Energy).

On the Sun, a constant nuclear fusion process generates energy that spreads through space in the form of electromagnetic radiation. Approximately 1.5×10^9 terawatt-hours (TWh) of this energy reaches the Earth's surface after passing through the atmosphere.[9] By reflecting approximately 30% of the energy back into space, and absorbing 70% on Earth's surface (amounting to 1.05×10^9 TWh), solar energy quantities surpass the total reserves of coal and oil combined. Despite its inexhaustibility in terms of duration and quantity, solar energy currently contributes only 2-3% to global primary energy production (Smil, 1991).

The advantages of using solar energy compared to other energy sources include: its availability in unlimited quantities for the next 5 billion years, low maintenance costs during the operational period of solar systems, and the ease of transport and installation of solar panels on various surfaces. Because of these benefits, solar energy can be applied in locations where it's not feasible to transport or generate electricity from other sources. The production cost of solar panels has decreased by over 50% in the last 15 years. The manufacturing technology in the solar industry is continuously advancing, driven by innovations in quantum physics and nanotechnologies. Consequently, these advancements will significantly increase the efficiency and power output of solar panels (Stevanović et al., 2022).

It is necessary to mention the disadvantages of using solar energy. Recent production of solar panels is still characterized by high production costs.[9] The efficiency of solar systems drastically decreases during nighttime, seasonal changes, and varying weather conditions. Due to the specific nature of solar energy production, it must be immediately used or stored in batteries, which still represent a significant cost in the construction of solar systems. It is common practice to supply excess solar energy produced during the day to electrical distribution systems, while at night, during production deficits, the same energy is taken from the distribution grid. Considering that the amount of solar energy produced depends proportionally on the size of the solar panel and the amount of sunlight reaching the panel, solar panels often occupy large areas and must be placed where sunlight can reach them without obstruction or shadows for most of the day. Although environmental pollution during the production of solar energy is negligible compared to other energy sources, the production of solar energy is associated with environmental pollution[10] (Vierda, 2018).

Discussion

When analyzing Bitcoin mining investments, it is essential to understand the cycles through which Bitcoin's value fluctuates. The cryptocurrency market resembles traditional stock exchanges in many ways. Consequently, the value of Bitcoin and other cryptocurrencies moves through two fundamental cycles: bull market and bear market (Gonzalez & Shi, 2006). Bull markets are characterized by a strong, impulsive rise in the value of Bitcoin, often accompanied by positive news related to the cryptocurrency market. During this cycle, Bitcoin typically reaches new all-time highs (ATH). In contrast, bear markets are marked by significant declines in the value of Bitcoin and all other crypto currencies. In a bear cycle, Bitcoin usually drops to values that are 70-80% lower than the peak achieved at the beginning of this cycle (see Graph 1)[11]. Depending on the global economic situation, these cycles have alternated fairly predictably since Bitcoin's inception, occurring approximately every two years[12]. The beginning of a bull cycle is typically marked by the halving event while the end of a bull cycle and the beginning of a bear cycle are characterized by major changes in the global economy, often accompanied by negative news related to the crypto currency market. It is common practice for miners to sell their earned Bitcoins in the latter half of the bull period in anticipation of achieving a new ATH. New investments in Bitcoin mining infrastructure usually commence in the upcoming bear cycle.

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9   The continuous increase in solar system production, particularly in China, along with their growing use in energy production, will certainly lead to a decline in the prices of these systems in the future.

10   However, this concerns indirect pollution that occurs during the production, transportation, and installation of solar systems.

11   https://www.tradingview.com/chart/?symbol=BITSTAMP%3ABTCUSD   (from 08.11.2021. to 21.11.2022. price of Bitcoin dropped for approximately 79%)

12   https://www.tradingview.com/chart/?symbol=BITSTAMP%3ABTCUSD   (bull   cycle occured from 01.04.2019. to 08.11.2021. while bear cycle occured from 15.11.2021. to 13.03.2023.)

**Figure 1.** Monthly movement of Bitcoin value during one cycle (from 01.01.2020. to 01.02.2024.

Source: Tradingview (https://www.tradingview.com/chart/?symbol=BITSTAMP%3ABTCUSD)
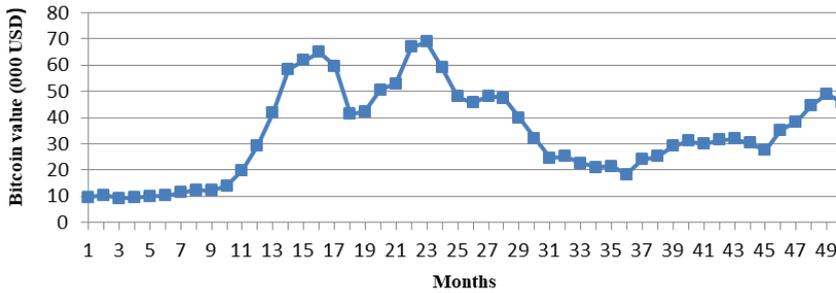
Since its inception in 2010, the value of Bitcoin has been constantly growing, although followed by corrections, on a macro level it's in an constant upward trend. The lowest price of Bitcoin was $0.09 in 2010, and the highest was $68,436 in 2021. This represents a significant increase of 76,039,900%. The first notable price spike occurred in 2014 when one Bitcoin was valued at $754.22. Another significant increase happened in 2018 when one Bitcoin reached $13,657.20. A parabolic rise in value began at the onset of the COVID-19 pandemic, with Bitcoin's value increasing from $7,200 at the beginning of 2020 to $29,374 in 2021. Later that year, it reached a new all-time high of $68,436. The rate of change in Bitcoin's value was 183.39%. Analyzing the movement of Bitcoin's value during one cycle reveal significant fluctuation.

Figure 2. Value movements of Bitcoin and gold from 2010 to 2023.

Source: Tradingview *(https://www.tradingview.com/chart/F1w4jrZc/?symbol=TVC%3AGOLD)*
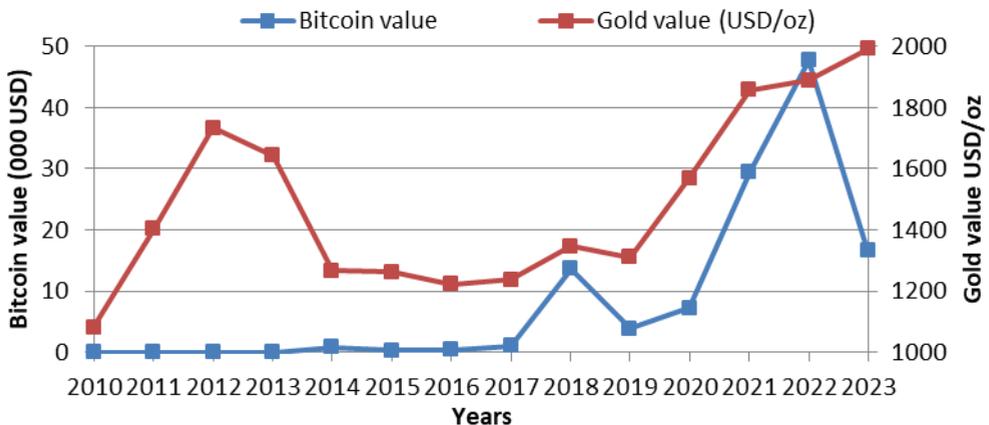
Therefore, investors need to have a clearly defined moment in the cycle of price movements when they will sell their mined Bitcoin to achieve the highest profit. The value of Bitcoin during the last cycle ranged from $9,553 to $68,789 (Graph 1). Given that Bitcoin is now considered "digital gold," it is often compared to gold from an investment perspective over the long term. According to data from the trading view website[13] the price of gold in the observed period also varied, from a low of $1,081.48 per ounce in 2010 to $1,991.41 per ounce in 2023. The price of gold in the mentioned period increased by 84.14%, while Bitcoin increased significantly more, by 18,472,222%. From the above, it can be concluded that if an individual had invested $100 in gold in 2010, by 2023 it would have been worth $184.14. However, if the same amount had been invested in Bitcoin, by 2023 it would have amounted to $18,472,122.20. Of course, it should be noted that gold is generally considered a relatively safe and low-risk investment in the financial world, whereas Bitcoin was initially seen as a highly risky investment. However, as Bitcoin has gained increasing significance, investing in it has become less risky, and a large number of individuals now include it in their investment portfolios.

Results

As previously mentioned, what "hinders" the acceptance of Bitcoin as an official means of payment on a global level is the energy consumption required for its mining. A significant portion of the profits of Bitcoin mining companies goes towards electricity costs, which vary depending on the country where the company operates. The solution proposed in this paper is to transition to mining using renewable energy sources (RES), specifically solar energy. If a larger number of companies switched to Bitcoin mining using RES, it would quickly gain acceptance as a currency of payment by all countries worldwide. Of course, companies are aware of this problem and the potential solution, so they have already started directing their investments towards RES. The most commonly used RES are solar energy and energy from mini-hydro power plants. Solar energy is particularly attractive to investors because it is accessible to both large companies and individuals aiming to generate additional income through passive earnings.

To assess the profitability of investing in the construction of a solar power plant for Bitcoin mining in Serbia, the following parameters need to be considered:

1. The cost of the machine used for Bitcoin mining (increased by transportation and customs expenses),
2. The cost of the solar power plant that would meet the electricity needs of the Bitcoin mining machine,
3. The surface area where the solar power plant will be located,
4. Number of sunny days,
5. Bitcoin value.

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13 https://www.tradingview.com/chart/F1w4jrZc/?symbol=TVC%3AGOLD

After considering all the previous parameters, the profitability of the investment and the payback period can be estimated approximately. The realized profit from such an investment will largely depend on the value of Bitcoin at the time the investor decides to sell it. Given that the value of Bitcoin moves in cycles and experiences significant fluctuations, for the purposes of calculation in this study, the median value from the last cycle lasting 50 months will be used (Figure 1.).

Bitcoin mining is conducted using ASIC miners, specialized machines designed with sufficient hardware power for these operations. The price of ASIC miners varies depending on their hardware capabilities and profitability. The power of a miner is expressed in hashrate per second, and its profitability is determined based on this hashrate and the electricity consumption required for its operation. Currently, the most powerful ASIC miner on the market is the "Whatsminer M63S Hydro" model from MicroBT, which has a hashrate of 390 Th/s. It consumes 7,250 watts of power to operate.[14] According to the manufacturer's official website[15], the price of this machine is $11,000 USD. In addition to the machine's cost, customs duties must be considered, calculated as 15% of its value, amounting to $1,650 USD for this specific model. Transportation costs are included in the final price. Therefore, the total value of this machine "delivered at place" (DAP) amounts to $12,650 USD.

Table 1. Annual profit of the Bitcoin mining machine "Whatsminer M63S Hydro" based on the source of electricity in the Republic of Serbia* (USD)

Source of electrical energy	Earnings (USD)	Electricity costs (0,105 USD/kWh)	Profit (USD)
Non-renewable sources	9.542[16]	6.351	3.191
Solar power plant	9.542	1.950[17]	7.592

Source: Author's calculation
* Median price of Bitcoin during the last cycle: $31,198 USD

Green Bitcoin mining investment (Table 1.) is significantly more profitable when solar energy is used for mining compared to conventional energy sources. The following sections will determine the annual return and payback period of the green Bitcoin mining investment, specifically using solar energy for Bitcoin mining.

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14 https://whattomine.com/miners (28.12.2023.)

15 https://shop.whatsminer.com/products?token=null (28.12.2023.)

16 The value of $9.542 USD was obtained from a website specialized in calculating the profitability of ASIC machines for Bitcoin mining (https://whattomine.com/miners (28.12.2023.)

17 Even though it's a renewable energy source, there are electricity costs associated with solar power because the solar plant doesn't generate electricity at night. In calculating electricity costs, a time period of 6 hours at the lower tariff rate has been considered.

Table 2. Annual return on investment of green Bitcoin mining*

Source of electrical energy	Earnings (USD)	Total investment cost (USD)	Return on investment (%)
Solar power plant	7.592	193.000	3,94

Source: Author's calculation

*Median price of Bitcoin during the last cycle: $31,198 USD

Table 3. Payback period of investment in green Bitcoin mining*

Source of electrical energy	Earnings (USD)	Total investment cost (USD)	Payback period (years)
Solar power plant	7.592	193.000	25

Source: Author's calculation

*Median price of Bitcoin during the last cycle: $31,198 USD

The value of Bitcoin at $6,400 USD represents the lower limit of profitability for green Bitcoin mining, meaning it is the threshold below which minimal profit is realized or operations break even without losses. At this Bitcoin value, the annual electricity costs of around $1,950 USD are covered. Any Bitcoin value below this threshold would make green Bitcoin mining unprofitable, meaning the investor would operate at a loss. If the investor decides to transition from green Bitcoin mining to producing and selling green energy from a solar power plant, this investment could yield significant annual revenues. When calculating the profitability of producing and selling green solar energy, the feed-in tariff in Serbia should be included, which amounts to $0.17 USD per kWh.[18] The calculation is based on the average annual household electricity consumption in Serbia, which is 5,544 kWh[19]. Considering all factors, a 56 kW solar power plant would produce approximately 367,920 kWh annually in Serbia. Subtracting the average annual household consumption (5,544 kWh), the net production from the solar power plant would be approximately 362,376 kWh per year[20]. At the feed-in tariff rate of $0.17 USD per kWh, the solar power plant would generate a revenue of approximately $61,600 USD annually. This amount needs to be reduced by taxes and fees totaling around $1,950 USD per year for the 56 kW plant, as well as for the cost of purchased electricity during nighttime hours, which is also around $1,950 USD per year. This leaves an annual profit of approximately $57,703 USD. The construction costs of the 56 kW solar power plant amount to around $180,350 USD. Therefore, the annual return on this investment would be approximately 32%, with a payback period of around 3 years.

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18 Uredba o tržišnoj premiji i fid-in tarifi. "*Službeni glasnik RS",br. 45/2023-11, br. 90/2024-3 dr. uredba, Beograd. https://pravno-informacioni-sistem.rs/eli/rep/sgrs/vlada/uredba/2023/45/3/reg*

19 https://www.politika.rs/scc/clanak/455113/Domacinstva-u-Srbiji-trose-50-odsto-vise-struje-od-evropskih

20 This data were obtained in consultations with company „MT Komex" after their engineers internally performed calculations.

If mined Bitcoins were sold at the median price of $31,198 USD, it can be concluded that the production and sale of electricity from a solar power plant is far more profitable compared to green Bitcoin mining.

Conclusion

The concept of sustainable development today has a significant influence on shaping economic growth and policies development in almost all countries worldwide. Bitcoin, as a revolutionary payment method, emerged with the idea of decentralized value creation without the intervention of a central bank, providing users with anonymity and privacy in financial transactions. It represents a contrast to traditional money and is often referred to as digital gold. The advent of Bitcoin led to the creation of the cryptocurrency market, which functions as a unique form of exchange. Other cryptocurrencies have emerged thanks to Bitcoin, offering various solutions and possibilities across all sectors of the economy.

One of the main criticisms of Bitcoin is its environmental impact, as it is not aligned with the concept of sustainable development or being "green." Bitcoin mining requires a significant amount of energy consumption, thus negatively affecting the environment. However, advancements in technologies enabling better energy conversion from renewable sources can address this issue. Major companies in the Bitcoin mining industry are increasingly shifting towards renewable energy sources, directing their future investments in that direction. If Bitcoin were to become entirely "green," its acceptance as a global trading medium would become more certain.

When analyzing the profitability of green Bitcoin mining using solar energy, the investment cost and expected annual revenue must be considered. The cost of such an investment in Serbia would amount to approximately $193,000 USD. Given the median price of Bitcoin in the last cycle, which was $31,198 USD, the expected annual return on the total investment would be around 3.94%, with a payback period of approximately 25 years.

Transitioning from green Bitcoin mining to selling solar energy to power distribution companies would occur when the value of Bitcoin falls below $6,400 USD. Research indicates that greater profit is achieved through supplying solar energy compared to green Bitcoin mining.

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Conflict of interests

The authors declare no conflict of interest.

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