



The Role of Solar Energy in Securing Energy Supplies in Algeria

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Abstract:

This study aims to analyze and examine the role of solar energy in securing energy supplies in Algeria. It also aims to present the position of solar energy in ensuring energy security in the global market. This study has concluded that geopolitical crises are undeniably posing a significant threat to the stability of energy supplies today. It has become increasingly necessary to work towards enhancing production and supply within supply chains in labor markets, free from any political obstacles or other international crises. It is noteworthy that this has prompted many countries, such as China and the United States, to increase investments in renewable energy, particularly solar energy. Algeria has also followed suit on a global scale and worked towards improvement, contributing to development, albeit moderately. As a result, solar energy has now become a key contributor to global energy production. Ensuring energy supply security remains a vital issue both nationally and globally. Securing future energy supplies should be closely tied to the strategies of governments and companies working collaboratively to diversify energy sources, develop clean technologies, enhance sustainability, and promote international cooperation to prevent geopolitical tensions and achieve energy security sustainability.

Keywords: solar energy, energy security, energy supply security, Algeria

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1-Introduction:

Solar energy is currently considered one of the cleanest and most sustainable energy sources in the world, relying on harnessing sunlight to generate electricity or heat. Solar energy is also regarded as an innovative and environmentally friendly method to meet human energy needs, forming a crucial part of efforts to combat climate change and achieve economic and environmental sustainability. Consequently, solar energy represents a significant advancement in electricity generation, enabling the utilization of one of the largest renewable and freely available energy sources covering the entire surface of the Earth. Thanks to advanced technology, sunlight can be converted into clean electricity without the need for fuel or emitting harmful environmental pollutants. What makes solar energy even more attractive is its wide availability in most regions worldwide, including Algeria, which enjoys abundant sunlight throughout the year.

Solar energy holds significant importance in global energy supplies as a crucial type of renewable energy. Today, investment and adoption of solar energy are rapidly accelerating worldwide, with many countries integrating it into their policies. It represents a sustainable environmental resource, capable of mitigating environmental pollution, and lays the foundation for future generations' social responsibility by protecting and sustaining countries' energy resources. Thus, solar energy plays a prominent role in enhancing energy supply security worldwide. This technology plays a crucial role in achieving energy security within the context of the world's increasing reliance on renewable energy sources and the transition from fossil fuels to more sustainable and environmentally friendly energy sources. Algeria is among those countries actively pursuing various projects to harness renewable energy sources, with solar energy leading the way.

From the above, problematic aspects of this study revolve around the following key question:

what extent does solar energy contribute to securing energy supplies in Algeria?

Subsidiary Questions:

- What is the current status of solar energy in Algeria?
- What is the importance of achieving energy supply security in countries in general and in Algeria in particular?
- What efforts has the Algerian government made to ensure energy security through solar energy supplies?

To answer the study problem, we formulated **the following hypothesis :**

- First Hypothesis: There is significant importance of solar energy in achieving energy supply security in countries in general, and specifically in Algeria.
- Second Hypothesis: Algeria is making significant efforts to ensure energy security through solar energy supplies in the national market.

This research study also attempts to clarify the potential of solar energy in Algeria, with a focus on solar energy supply, along with analyzing the results of solar energy supplies in the global market, and the role of solar energy in securing energy supplies in Algeria.

2. Solar Energy

Solar energy refers to the radiant light and heat emitted by the Sun, which can be harnessed and converted into usable forms of power, typically through technologies such as photovoltaic cells or

solar panels. It is a renewable and sustainable source of energy that is abundant and widely available, offering the potential to reduce reliance on fossil fuels and mitigate environmental impacts associated with traditional energy sources.(A. Boudghene Stambouli, Z. Khiat, & S. Flazi, Y. Kitamura, 2012, p. 4449)

Solar power refers to the conversion of sunlight into electricity using photovoltaic cells or solar panels. These cells or panels absorb sunlight and convert it into direct current (DC) electricity, which can then be converted into alternating current (AC) electricity for use in homes, businesses, and industries. Solar power is a renewable and clean energy source that is abundant and widely available, making it an important component of efforts to reduce reliance on fossil fuels and combat climate change.(Dilki Dias Somanatha Arachchige, 2022, p. 41)

3. The concept of energy security

Energy security refers to the uninterrupted availability of energy sources at an affordable price. It encompasses various dimensions, such as physical security, economic security, environmental security, and social security. Energy security is essential for the functioning of modern societies and economies, as it underpins a range of critical activities, including transportation, industrial production, and heating and cooling of buildings.(Aidouni Layachi & Aiouadj Mokhtar, 2023, p. 61)

4. Achieving energy security in the global market

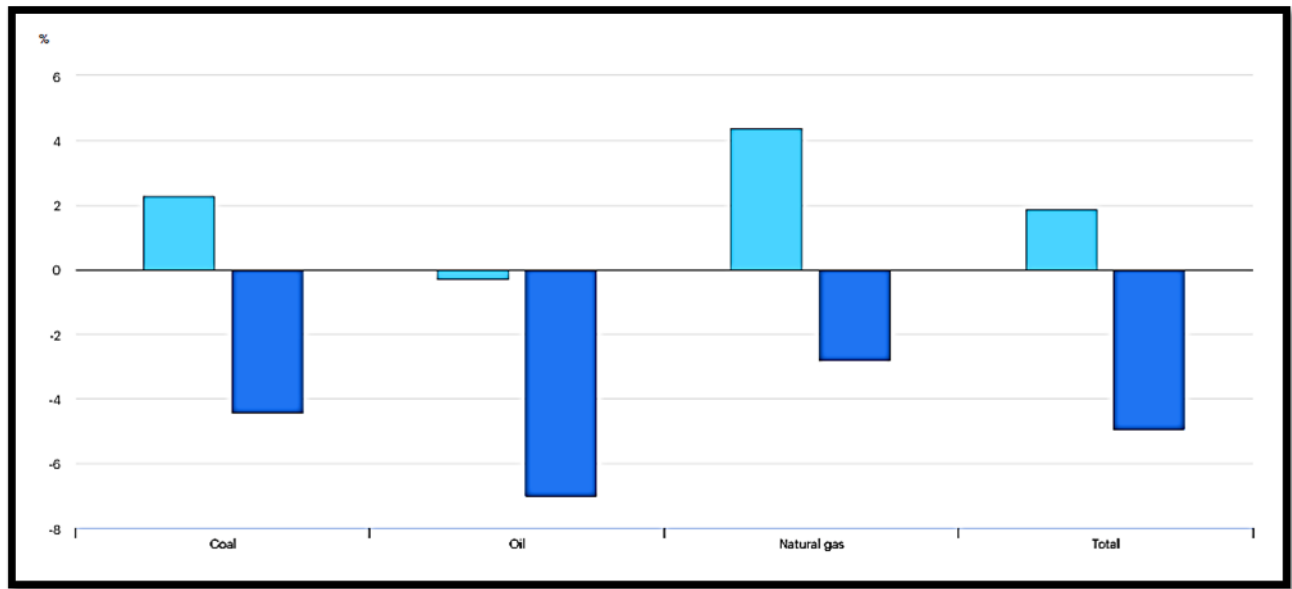
Achieving energy security in the global market holds significant importance for various reasons, primarily linked to a nation's or state's sovereignty. Among the reasons making energy security crucial are:

- Economic stability: The global economy heavily relies on energy supplies, whether oil, gas, or electricity. Working towards achieving energy security contributes to stabilizing prices and ensuring sustainable energy availability, thus fostering economic growth.
- Supply diversification: Energy security efforts help in providing multiple energy sources and diversifying supply sources, reducing vulnerability to oil price fluctuations and overreliance on specific exporting regions.
- Environmental protection: Transitioning to clean and sustainable energy sources can mitigate environmental pollution and climate change effects. Enhancing energy security through promoting renewable energy use and improving energy efficiency can contribute to environmental preservation.
- National security enhancement: Achieving energy security is a crucial aspect of national security. A country heavily reliant on energy imports may be susceptible to price fluctuations or geopolitical crises in supply regions. Providing local energy sources can increase a nation's independence and security.
- Encouraging investment and innovation: Promoting sustainable energy sectors encourages investment in technology and innovation, creating job opportunities and contributing to economic development.

- Working towards political stability: Achieving energy security can help reduce geopolitical tensions associated with energy routes and supply regions, contributing to international peace.

The International Energy Agency has clarified that the most significant energy supply sources mainly rely on fossil fuels, primarily oil, natural gas, and coal. This is evident to us through the following figure:

Figure N°01: Global average annual change in fossil fuel production and supply by fuel type between 2019 and 2020.



Source : <https://www.iea.org/reports/world-energy-balances-overview/world>, 05/10/2023.

Based on the previous figure, it is noticeable that for the year 2020, global production data is preliminary and limited to fossil fuels. According to data available from the International Energy Agency, fossil fuel production experienced a significant decline in 2020 compared to 2019 (-5%). All types of fossil fuels were affected, especially oil (-7%), due to reduced transportation demand during the global health crisis at that time. Coal production also decreased by 4%, according to preliminary agency data, attributed to the economic repercussions of the coronavirus, despite a strong economic recovery in China, the world's largest coal consumer, in the second half of 2020. Natural gas production was less affected but still decreased (-3%).(IEA, 2023)

As for solar energy, the most significant annual production and supply of solar energy - or installed photovoltaic energy - between 2018-2022 can be presented as follows:

Table No. 01: Major quantities of production and annual supply of solar energy - installed photovoltaic energy - between 2018-2022 **Unit: Megawatts**

Country	2018	2019	2020	2021	2022
China	175.263	205.060	254.055	307.068	393.127
United States of America	51.987	61.587	76.441	95.391	113.015
Germany	45.158	48.914	53.671	59.373	66.554
Brazil	2.435	4.635	8.291	14.197	24.079
South Africa	4.805	4.908	5.995	6.316	6.326

Source : Energy Institute Statistical Review of World Energy 2023, p48, download: 05/10/2023, address: https://www.energyinst.org/__data/assets/pdf_file/0004/1055542/EI_Stat_Review_PDF_single_3.pdf

From the above table, it is noticeable that among the most important solar energy-producing countries, ensuring supplies for both domestic and international consumers of clean energy, China stands out. China's production grew from 175.263 megawatts in 2018 to 393.027 megawatts in 2022, representing a growth rate of approximately 124.30%. The second-largest producer and supplier of solar energy globally is the United States, with its production estimated at 51.987 megawatts in 2018, soaring to 113.015 megawatts in 2022, marking a growth rate of about 117.39%. Germany follows as the third-largest solar energy producer globally, with production reaching approximately 45.158 megawatts in 2018 and rising to 66.554 megawatts in 2022, reflecting a growth rate of around 47.38%. Brazil leads in Latin America for solar energy production, with an estimated production of 2.435 megawatts in 2018, surging to 24.079 megawatts in 2022. Lastly, South Africa serves as Africa's foremost producer, exporter, and contributor to the global solar energy market, with production increasing from 4.805 megawatts in 2018 to 6.326 megawatts in 2022.

Also, it is noticeable that countries have been increasingly focusing on renewable energies, with solar energy leading the way. This is evident from the increased investment and record-breaking growth in production.

Moreover, it can be said that there is a key factor driving international interest in solar energy. Energy security enhances economic, social, and political stability worldwide, which is essential for ensuring energy sustainability, reducing negative environmental impacts, and ensuring national security. Statistics and figures confirm this, illustrating its importance in achieving energy security in the global market.

Global energy consumption, according to data published by the International Energy Agency for the year 2021, reached around 167,000 terawatt-hours (TWh) annually. The International Energy Agency expects this consumption to increase by 1.3% annually until 2040. (IEA, 2023)

Relying heavily on continuous oil dependence poses the primary challenge to energy security. According to data, oil accounts for approximately 33% of global energy consumption, primarily

used in transportation and industry sectors. Diversifying energy sources today is deemed essential amid the global crisis, notably exacerbated by the Russian-Ukrainian war, which caused a significant energy supply crisis in the global market. Therefore, the importance of diversifying energy sources to achieve energy security for all countries is increasing, especially with efforts to reduce reliance on natural gas, which constitutes about 24% of global energy consumption, while electricity represents about 19%, and coal around 27%.

Consequently, this drives investments in renewable energy in general, and solar energy in particular, since the beginning of the 21st century. Investments in renewable energy have witnessed significant growth. In 2020, investments in renewable energy reached around \$303 billion USD according to the International Energy Agency. This directly ensures the preservation of national energy sources for countries, as many nations heavily rely on domestic energy sources to achieve energy security. This is observable in the United States, which meets about 90% of its electricity needs from local sources, including coal, natural gas, and nuclear energy.(IEA, 2023)

Furthermore, it is impossible to ignore the geopolitical impact on the security and supply of energy. Political crises and conflicts in oil and gas-producing regions highlight the importance of achieving energy security. This is evident through the significant influence and repercussions on global oil markets in recent years due to tensions in regions such as Eastern Europe, the Middle East, North, and Central Africa. Therefore, these changes and impacts underscore the importance of achieving energy security in the global market. This highlights the need to diversify energy sources and increase investment in sustainable energy, particularly solar energy, to contribute to the sustainability of global energy supplies and reduce dependence on major energy sources.

5. The Reality of Solar Energy in Algeria

In Algeria, solar energy has witnessed significant development and progress in recent years. The Algerian government has embarked on numerous projects aimed at achieving tangible advancement in harnessing solar energy in the country. The composition of energy production and supply in the Algerian market for the year 2022 can be presented as follows:

Table N°02: Composition of Energy Production and Supply in the Algerian Market for the Year 2022

Power type	Natural Gas	Crude oil	Other sources of energy
The ratio (%)	65	33	02
Percentage of contribution to electricity production (%)	99	-	01

Source: <https://premier-ministre.gov.dz/ar>, 01/10/2023.

It is noteworthy that natural gas constitutes the primary source of energy in Algeria at 65%, while oil represents 33%. Natural gas is also the main source for electricity production, accounting for approximately 99%, with only 1% coming from other energy sources, including solar energy, in addition to its extensive use in industrial activities. As a result, domestic consumption is increasing due to demographic growth, while production is slowing down.

On the other hand, Algeria boasts vast potential in harnessing solar energy, with an estimated solar field ranging from 2500 to 3600 hectares per year. The energy transition relies on developing a national industry for renewable electricity production equipment, especially solar energy. Importing solar panels, for instance, is costly compared to importing the energy used in their production. Therefore, true exploitation of energy lies in producing its own means. As a first step, this is financed by current revenues from oil and gas, focusing on enhancing exploration and improving yields from existing fields, as well as development and refining in order to achieve fuel independence by the end of 2021. Additionally, supportive programs and policies for renewable energy, particularly solar energy, are being implemented. The Algerian government adopts supportive policies and programs to promote solar energy utilization, including supporting the development of solar energy projects and encouraging investments in this sector. (premier-ministre, 2023)

As per the report issued by the International Renewable Energy Agency regarding Algeria, the results of solar energy production and supply at the Algerian territory level from 2018 to 2022 can be presented through the following table:

Table N°03: Solar Energy Production and Supply at the Algerian Territory Level
from 2018 to 2022 **Unit: Megawatts**

Years	2018	2019	2020	2021	2022
Algeria	448	448	448	448	460
Growth rate	-	-	-	-	02.67

Source : Energy Institute Statistical Review of World Energy 2023, p48, download: 05/10/2023, address: https://www.energyinst.org/__data/assets/pdf_file/0004/1055542/EI_Stat_Review_PDF_single_3.pdf

As evident from the previous table, solar energy production and supply in Algeria are weak and barely noticeable. In 2022, the growth rate was only 2.67%. This underscores the need for the Algerian government to take more action to rectify these results and increase investment in this energy source.

The International Renewable Energy Agency also highlighted a discrepancy in energy production levels in Algeria, which can be elucidated through the following table:

Table N°04: Energy Production Sources in Algeria for the Year 2021

Unit: Gigawatts

power source	Production and supply value	(%)
non-renewable energy	84.729	99
Marine-water hydraulic energy	09	-
solar energy	760	01
Wind Energy	11	-
Vital energy	0	-

Geothermal energy	0	-
Total renewable energy	780	01
Total	85.509	100

Source :IRENA - International Renewable Energy Agency 2023,p 03, download: 05/10/2023, address:
https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Africa/Algeria_Africa_RE_SP.pdf

From the preceding table, it is evident that there is a clear deficiency in the development and enhancement of renewable energies in Algerian production. Most of the energy is derived from fossil fuels, including coal, oil, and gas, with only 760 gigawatts of solar energy, representing just 1% of the total energy produced in Algeria.

Nevertheless, it cannot be denied that Algeria has worked on establishing a suitable framework to improve investment and growth in renewable energies, particularly solar energy. There has been a noticeable development in electricity generation capacity from natural sources. Algeria today has immense potential for solar electricity generation due to its vast expanses and abundant sunshine throughout the year. Large solar power stations have been constructed in the country, including significant projects such as the "Tamanrasset" project with a generation capacity of up to 344 megawatts and the "Béchar" project with a generation capacity of 150 megawatts. These projects contribute to meeting the country's electricity needs.

Furthermore, Algeria is considering the possibility of exporting renewable energy. The country aims to develop its solar energy capabilities to meet its national needs and potentially export surplus electricity to neighboring countries, including Europe.(premier-ministre, 2023)

6. Algeria's Efforts to Enhance the Position of Solar Energy versus Fossil Fuels in the Algerian Market

Since the economic crisis of 1986, Algeria has been working to reduce reliance on fossil fuels in the state budget. Today, it is focusing on optimizing the use of renewable energy, particularly solar energy. There are numerous projects and measures that could contribute to improving the position of solar energy compared to fossil fuels in the Algerian market. Algeria has been striving to enhance its investments in large-scale solar energy projects aimed at generating significant amounts of electricity. These projects can greatly contribute to meeting the country's electricity needs and reducing reliance on diesel and natural gas. Additionally, the government is promoting household solar use and providing incentives and facilitations for homes and businesses to install solar energy systems on their rooftops.

It is noteworthy that as of 2021, Algeria had a total solar energy generation capacity of approximately 400 megawatts. The Tamanrasset project stands out among these projects as the largest solar energy project in Algeria and one of the largest in the world, with an estimated generation capacity of around 344 megawatts. According to statistics published by the Prime Minister's website, electricity demand in Algeria is increasing at a rate exceeding 7% annually. In 2011, the government launched a program to develop renewable energies aimed at providing about 22,000 megawatts of renewable sources between 2011 and 2030, including 12,000 megawatts allocated for national electricity demand and 10,000 megawatts for export.(premier-ministre, 2023)

Despite the importance placed on this program, it did not fully achieve its goals. In 2015, the initial target of producing 40% of electricity from renewable sources by 2030 was revised downward to just 27%. Algeria is striving to achieve this revised target before the specified deadlines. To accelerate the development of renewable energies, the Renewable Energy and Energy Efficiency Directorate was established under the Prime Minister's Office in 2019, along with the Ministry of Energy Transition and Renewable Energies in 2020. The roadmap for this new ministry aims to achieve a 30% integration rate of electricity production by 2030, starting with the provision of 1000 megawatts of renewable electricity.(premier-ministre, 2023)

It's noticeable that the transport and housing sector tops the priorities of the roadmap with a 10% reduction in energy consumption by 2021. To achieve this goal, one hundred thousand solar water heaters will be installed in 2021, allowing for energy savings of up to 40%. This initiative also supports the local industry of solar-powered water heaters while bolstering renewable energy. Additionally, there's a target to increase the share of renewable energy in the energy mix. A national plan for renewable energy development has been launched targeting increased utilization of solar, wind, and natural gas energy.

On August 14, 2019, the Electricity and Renewable Energies Company in Algeria, SKTM, a Sonelgaz subsidiary, signed agreements with five companies to implement nine power generation stations using photovoltaic solar and diesel technologies. All stations will be built in the southern regions with a total capacity of 50 megawatts. Projects include Ain Khezzane (6 MW), Tinzaouten (3 MW), Jant (4 MW), Bough Omar Driss (3 MW), Bough Bagiar (10 MW), Timeyoun (2 MW), Taminaouin (8 MW), Tablabballa (3 MW), and Tindouf (11 MW).(Renouvelables, 2023)

However, despite all these efforts and projects, Algeria faces significant challenges in developing solar energy, including the necessary investments, infrastructure development, technical and technological training. Yet, these challenges will not be a barrier to impede the wheel of progress. Algeria is expected to continue enhancing its capabilities in the field of solar energy with the increasing global interest in renewable energy. This sector will play a crucial role in achieving energy security and meeting the growing electricity and energy needs in the country. Algeria also aims to significantly increase its capacity in the field of solar energy in the coming years and increase the proportion of renewable energy in its energy mix. This requires the success of the energy transition in Algeria, fostering an environment conducive to innovation and entrepreneurship. Additionally, the use of new renewable energies must be coupled with the development of competitive industrial sectors capable of competing internationally.

7. Conclusion

In conclusion, solar energy emerges as an innovative and efficient solution to ensure energy security in global markets, as evidenced by figures and statistics supporting this trend. In 2020, global installed solar capacity increased by approximately 15%, according to UNCTAD and the International Energy Agency. This upward trend is expected to continue in the coming years. Additionally, the cost of installing solar energy systems is expected to decrease significantly in the future, making it more attractive to both companies and individuals.

Furthermore, the role of solar energy in providing energy security in Algeria has shown tangible success despite being moderate. According to statistics from the Algerian Ministry of Energy and Mines, over 400 megawatts of solar energy have been installed in the country as of 2021. This investment in solar energy has significantly reduced reliance on fossil fuels and diversified energy sources. Efforts have also been directed towards developing large-scale solar energy projects in Algeria, such as Ain Guzam (5 MW), Tizouatine (3 MW), Jant (4 MW), Bourj Omar Driss (3 MW), Bourj Baji Mokhtar (10 MW), Timiaouine (2 MW), Tablabal (3 MW), and Tindouf (11 MW).

These efforts reflect Algeria's commitment to enhancing energy supply sustainability and ensuring energy security, which contributes to boosting the local economy and reducing carbon emissions. These figures and statistics indicate that Algeria is on the right path towards achieving its solar energy goals and ensuring energy supply security in the future.

Based on what has been presented, we can test the hypotheses of the study and accept or reject these hypotheses as follows:

- Hypothesis 1: There is significant importance of solar energy in achieving energy supply security in countries in general, and specifically in Algeria. As previously discussed, this hypothesis is valid, as solar energy plays a crucial role in enhancing energy supply security in countries overall and specifically in Algeria for various reasons. Solar energy contributes to diversifying energy sources, reducing reliance on fossil fuels, mitigating their negative economic and environmental impacts, and ensuring sustainability. In Algeria, solar energy plays a vital role in achieving these benefits to a greater extent, given the country's abundant solar resources and vast potential for solar energy projects, thus enhancing energy supply sustainability and contributing to energy security.
- Hypothesis 2: Algeria is making significant efforts to ensure energy security through solar energy supplies in the national market. As previously discussed, this hypothesis is valid, as Algeria has made substantial efforts to ensure energy security through solar energy supply in the domestic market through various means. This includes increasing solar capacity by investing in the development and expansion of installed solar capacity significantly. Additionally, large-scale solar energy projects have been established to enhance electricity supply and reduce dependency on fossil fuels. Algeria also collaborates internationally to develop solar energy projects and increase sustainability in this sector. These efforts reflect Algeria's commitment to enhancing energy security by leveraging its rich solar energy resources, reducing reliance on fossil fuels, and promoting energy supply sustainability.

Thus, it is possible to present the key findings of this study, which include the following:

- It is observed today that global markets are working to improve various energy supplies, whether renewable or non-renewable, due to their importance in global commodity production and thus achieving economic growth for countries.
- Despite the diversity of energy sources, from a supply security perspective, they mostly rely on non-renewable energy sources, mainly gas, coal, and oil. Traditional sources are preferred over renewable energy sources, despite the need to diversify energy sources and work towards sustainable development.

- In most cases, there is a necessity to secure unstable and energy-producing regions, which contributes to the stability of producing areas. Energy supply security is affected by political and economic stability in oil and natural gas-producing regions.
- There is a close connection between technology and renewable energy, as there is an increasing use of renewable energy technologies, mostly relying on modern technology, which is lacking in developing countries, including Algeria. This complicates the production and supply processes of renewable energies, particularly solar energy.
- Despite the weak production and supply of solar energy at the national level in Algeria, the Algerian state continues to work on improving investment, infrastructure, and providing specialized labor for this purpose. This requires time to achieve significant tangible results and growth in this promising sector, especially solar energy.

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