The Use of Photovoltaic Technology in Albania: A Good Opportunity to Face the Energy Crisis

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Abstract

Albania is a country with a great potential for solar energy due to its geographical location and favorable climate conditions. Albania's high levels of sunlight offer a chance for the nation to use PV technology to harness solar energy. Currently, the total installed capacity of solar energy in Albania is around 70 MW, which represents only a small fraction of the country's potential. Most of the existing solar power plants in Albania are small-scale installations, with a capacity of less than 5 MW. This paper will focus on the use of photovoltaic (PV) technology in Albania as a potential solution to the energy crisis that the country currently faces. Albania, like many other countries, relies heavily on imported fossil fuels for its energy needs. Due to this dependence, the country's economic growth and development are severely damaged by the oil crisis. In addition to lowering Albania's reliance on fossil fuels, the deployment of PV technology can help the country develop a sustainable and ecologically friendly energy system. The adoption of PV technology can also foster economic expansion and generate new job possibilities. The future of PV technology in Albania looks promising, as the country continues to implement policies and incentives to encourage investment in renewable energy sources. However, there are a number of obstacles to the adoption of PV technology in Albania, including poor infrastructure, a lack of funding, and low technical know-how. Participation from both, the public and business sectors as well as international organizations will be necessary to address these difficulties. The use of PV technology in Albania presents a good opportunity to address the country's energy crisis and transition towards a sustainable energy system. With proper investment and support, Albania can become a leader in solar energy in the region, creating a positive impact on the environment and the economy.

Keywords: *photovoltaic (PV) technology, energy crisis, favorable conditions, sustainable energy*

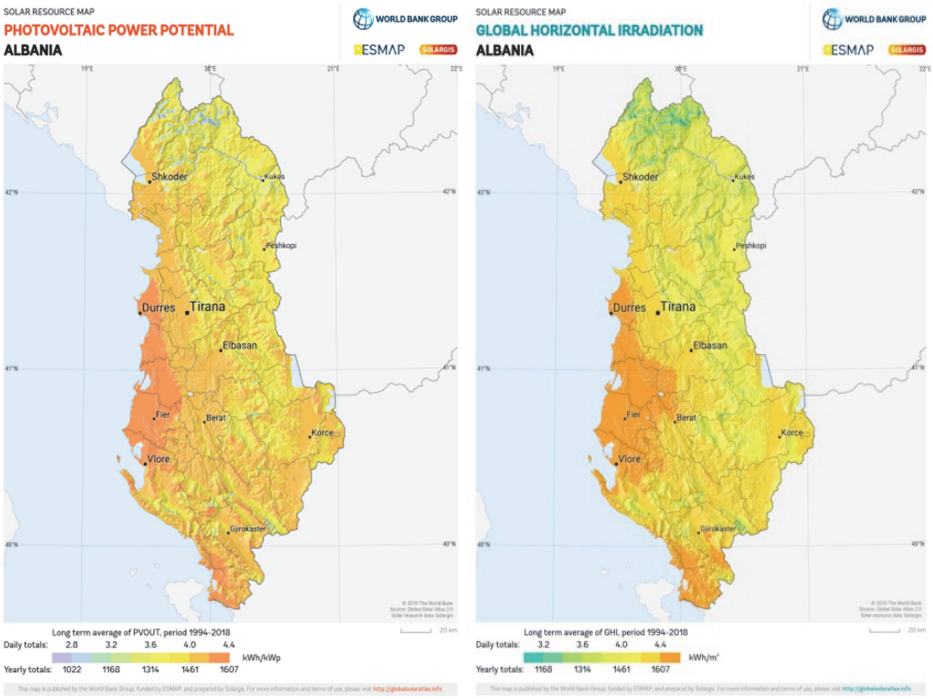
1. Introduction

Albania has been facing an energy crisis for several years due to its heavy reliance on hydropower, which accounts for over 90% of its electricity production. The country's energy sector has been hit by prolonged droughts in recent years,

resulting in a severe reduction in hydropower[1] generation capacity. This has led to frequent power outages, which have had a significant impact on the country's economy and daily life.

Albania's energy crisis has been compounded by several factors, including its outdated energy infrastructure, inadequate investment in energy projects, and a lack of diversification in energy sources. The country's aging transmission and distribution systems have also contributed to the problem, as they are unable to cope with the fluctuating supply and demand of electricity. In an effort to address the energy crisis, the Albanian government has taken several measures, such as investing in renewable energy sources, including solar and wind power, and upgrading the country's energy infrastructure.

The government has also signed agreements with neighboring countries to import electricity during times of shortage. Despite these efforts, the energy crisis in Albania remains a significant challenge, and there is a need for continued investment and development of alternative energy sources[2] to address the country's energy needs and reduce its dependence on hydropower. Albania gets about 2100–2700 hours of sunshine in a year so it has a great potential for solar energy (figure 1).



[1] *Albania, June 2022: The price of electricity is 0.108 U.S. Dollar per kWh for households and 0.119 U.S. Dollar for businesses which includes all components of the electricity bill such as the cost of power, distribution and taxes.*

[2] *Albania is one of the few countries around the world that are 100 percent reliant on renewable energy*

Figure 1. Solar resource maps of Albania

Solar energy is easily accessible since most energy comes directly or indirectly from the sun. It could be used for heating and lighting homes, commercial, and industrial buildings. Photovoltaic (PV) technology is a method of generating electrical power by converting solar radiation into direct current electricity using semiconducting materials. PV systems consist of multiple PV modules, which are interconnected and mounted on a supporting structure. The electricity generated by the PV modules can be used immediately or stored in batteries for later use. PV technology is a promising alternative to traditional fossil fuel-based energy sources, as it is renewable environmentally friendly, and has the potential to be cost-effective over the long term.

The Albanian government has set ambitious targets for the development of renewable energy sources, including solar energy and has implemented a number of measures to encourage investment in solar energy, including feed-in tariffs, tax incentives, and streamlined administrative procedures for project development. The National Renewable Energy Action Plan (NREAP) aims to increase the share of renewable energy in the country's energy. The Albanian Power Corporation (KESH) is the main operator of the country's electricity system, and it has been investing in the development of solar energy projects in recent years. Private investors have also shown interest in developing large-scale solar power plants in Albania, attracted by the country's favorable conditions and government support.

2. Methodology

The objective of this study is to evaluate the potential of photovoltaic (PV) technology as a viable and sustainable solution to the energy crisis in Albania. The study aims to assess the technical and economic feasibility of implementing PV systems in Albania, analyze the potential environmental benefits, and explore the social acceptance and cultural factors that may influence the adoption of PV technology. By conducting this evaluation, the study seeks to provide valuable insights and recommendations for policymakers, energy companies, and other stakeholders to promote the effective utilization of PV technology as a means to address the energy crisis and contribute to a more sustainable energy future in Albania.

To see the efficiency of photovoltaic systems, we examined the on-grid system. The cost of an on-grid solar

system is lower than other types of solar systems because there are no batteries. It also generates the highest amount of energy compared to other types of solar systems. We have made an energetic comparison. We have referred to the monthly consumption of 979:41kW, from which it appears that the annual consumption of electricity is approximately 8656:92kW. For a year PV produce 13833 kW of electricity. Thus we have about 5000 kW more to use for a year. For one year we are obliged to pay about 120 thousand ALL. For about 8 years, we will have to spend approximately 10 million ALL as much as the cost of the panels of the on-grid system. Approximately 8 years we take out the investment made. Since the warranty of the panels is 15 years, for 7 years we use them for free, so for 7 years we have exactly 96 831 kW of free electricity.

3. Literature Review

3.1 PV Technology and Energy Crises

PV (photovoltaic) technology, also known as solar energy, has emerged as a promising solution to address the ongoing energy crises around the world. With the depletion of fossil fuel reserves, the rising costs of energy production, and the growing concerns about environmental pollution and climate change, PV technology offers a sustainable and renewable alternative. PV technology harnesses the power of sunlight and converts it into electricity using solar panels. These panels contain photovoltaic cells that generate an electric current when exposed to sunlight.

The adoption of PV technology has seen significant growth in recent years due to several factors. First, advancements in technology have led to improved efficiency and reduced costs of solar panels, making them more accessible to a wider range of consumers. Additionally, governments and organizations worldwide have implemented supportive policies and incentives to encourage the deployment of solar energy systems.

The benefits of PV technology are manifold. Solar energy is a clean and renewable source of power, producing zero greenhouse gas emissions during operation. It reduces dependence on fossil fuels and enhances energy security.

3.2 Case Studies on PV Implementation

These case studies demonstrate the successful implementation of PV technology in different contexts. They showcase the importance of supportive policies, incentives, and innovative business models in driving the widespread adoption of solar energy and overcoming barriers to entry. Two case studies that highlight the successful implementation of PV technology:

Germany's Energiewende, meaning "energy transition," is a notable case study in the widespread implementation of PV technology. Large-scale solar farms were constructed, and rooftop solar installations became commonplace. The country's commitment to renewable energy and PV technology allowed it to become a global leader in solar energy production.

Solar City's Solar Leasing Model in the United States, part of Tesla, implemented an innovative business model to drive the adoption of solar energy in the United States. The company introduced a solar leasing program that allowed homeowners to install solar panels with little to no upfront costs. Solar City's innovative solar leasing model contributed to the rapid growth of the residential solar market in the United States and influenced similar programs implemented by other solar companies.

3.3 PV Technology in Albania

3.3.1 Solar Resource Potential

Albania has a favorable solar resource potential, making it suitable for the implementation of solar PV technology. Some key points regarding the solar resource potential in Albania are:

Solar Irradiation Levels: Albania receives a substantial amount of solar irradiation due to its geographical location in the Balkan Peninsula. Albania enjoys a high number of sunny days, contributing to a reliable solar resource. The average annual sunshine duration in the country ranges from 2,200 to 2,800 hours, depending on the location. This extended duration of sunlight provides a consistent solar resource, which is essential for the efficient operation of PV systems.

The solar energy density in Albania is relatively high, particularly in the southern regions. Solar energy density

refers to the amount of solar energy that reaches a specific area over a given time period. The high solar energy density in Albania translates to a greater potential for electricity generation from solar PV systems. Albania's latitude, which falls within the range of 41° to 42° , North positions the country in a favorable zone for solar energy generation. The climate in Albania is Mediterranean, characterized by hot summers and mild winters, providing optimal conditions for solar energy capture throughout the year. Harnessing the solar resource potential in Albania through the implementation of solar PV technology can help the country tap into a clean and sustainable energy source. The abundant sunlight and favorable climatic conditions provide a solid foundation for the efficient and effective generation of solar energy.

3.3.2 Current Energy Situation in Albania

The current energy situation in Albania is characterized by a mix of energy sources, with a significant reliance on hydropower and a growing focus on diversifying the energy mix. Historically, hydropower has been the primary source of electricity generation in Albania. The country is endowed with numerous rivers and mountainous terrain, providing ample opportunities for hydropower development. Hydropower plants account for a substantial portion of the country's electricity generation capacity. Albania has been reliant on energy imports to meet its energy demands. In the past, the country has imported electricity from neighboring countries to supplement its domestic generation capacity, particularly during periods of peak demand. Energy imports have contributed to energy security concerns and dependence on external sources.

Albania is making efforts to diversify its energy mix and reduce dependence on hydropower and energy imports. The government has been implementing policies and initiatives to promote renewable energy sources, including solar, wind, and biomass. This shift towards diversification aims to enhance energy security, reduce greenhouse gas emissions, and promote sustainable development. Albania has untapped potential for renewable energy development, including solar and wind energy. The government has introduced supportive policies and incentives to encourage investments in renewable energy projects. These efforts aim to increase the share of renewable energy in the overall energy mix and reduce dependence on fossil fuels.

Albania faces challenges in its energy sector. These include the need for infrastructure modernization, improving energy efficiency, and attracting investments in renewable energy projects. Albania has been undergoing energy sector reforms to improve efficiency, attract private investments, and ensure a competitive and transparent energy market. These reforms aim to create a favorable environment for renewable energy investments and promote a sustainable and reliable energy sector.

3.3.3 Policies and Incentives

Albania has implemented several policies and incentives to promote renewable energy, including solar PV, and attract investments in the sector. These policies aim to create a favorable environment for the development and deployment of renewable energy projects. The Albanian government has established feed-in tariff schemes to incentivize renewable energy generation, including solar PV. Feed-in tariffs provide fixed, long-term electricity purchase prices for renewable energy producers. This mechanism guarantees a stable and attractive return on investment for renewable energy projects, encouraging the development of solar PV installations. The government facilitates the signing of power purchase agreements between renewable energy producers and electricity distribution companies. PPAs ensure a predetermined price for the electricity generated from renewable sources, providing revenue certainty for project developers. This mechanism supports the bankability of solar PV projects and encourages private investment.

Net metering regulations enable electricity consumers with solar PV systems to offset their energy consumption with the electricity they generate. Excess electricity fed back into the grid is credited against future electricity consumption. Net metering encourages the adoption of rooftop solar PV systems by residential, commercial, and industrial consumers, as it offers financial savings and promotes self-consumption of renewable energy. The Albanian Energy Regulatory Entity (ERE) has established a green certificate system. Renewable energy producers, including solar PV projects, are eligible to receive green certificates for each megawatt-hour of electricity generated from renewable sources. These certificates can be sold in the market to obligated electricity suppliers, providing an additional revenue stream for renewable energy projects. The government provides tax incentives to support renewable energy investments, including solar PV. These incentives may include tax exemptions, reduced tax rates, or tax credits for equipment purchases, installation, and operation of renewable energy systems.

3.3.4 PV Installations and Projects in Albania

Albania has witnessed an increase in PV installations and projects in recent years as the country seeks to diversify its energy mix and promote renewable energy sources. Some notable PV installations and projects in Albania are:

Spitalle Solar Park is one of the largest solar installations in Albania. Located in the Durres region, the park has a capacity of 140 MW and covers an area of approximately 193 hectares. It consists of thousands of solar panels and contributes significantly to the country's renewable energy capacity.

Akerni PV Plant, situated near Fier, is another prominent solar project in Albania. With a capacity of 100 MW, it comprises a large number of solar panels and contributes to the renewable energy generation in the country. The project helps diversify the energy mix and reduce dependence on fossil fuel-based electricity generation.

Vlora PV Power Plant is a significant solar project located in the Vlora region. With a planned capacity of 140 MW, it aims to harness the abundant solar resource potential in the area. The project is expected to contribute to the renewable energy goals of Albania and enhance the country's energy security.

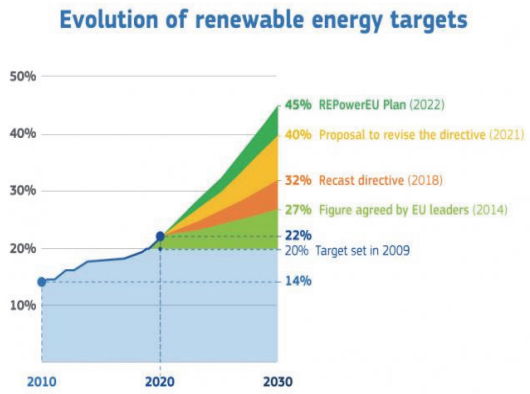
Project “Karavasta Solar Power Plant (SPP)”, a 140 MWp SPP located in the municipality of Fier in Albania (the "Project"). The Project adopted on 15 Nov 2022 will contribute to climate mitigation by meaningfully increasing the share of solar power generation in Albania and will promote further private participation in the sector dominated by public hydro power assets and imported energy.

Project "Sun Edison Albania": This project was implemented by the American company "Sun Edison" and consisted of the installation of a 1 MW photovoltaic power plant in the city of Elbasan. The project was completed in 2014 and was funded by private investment. It consisted of 4,000 solar panels and was expected to generate enough electricity to power more than 700 households in the area.

Project "Fier Solar Park": This project was implemented by the Albanian company "Energji Ashta" and consisted of the installation of a 2 MW photovoltaic power plant in the city of Fier. The project was completed in 2015 and was funded by private investment. It consisted of 7,500 solar panels and was expected to generate enough electricity to power more than 1,000 households in the area.

These successful projects demonstrate the potential for photovoltaic technology in Albania and the benefits it can bring to the country, including the development of a sustainable energy industry, job creation, and reduced greenhouse gas emissions. Albania currently subsidizes large-scale PV through a series of tenders. It also supports rooftop PV through a net-metering scheme. According to the latest statistics from the International Renewable Energy Agency (IRENA), the country's cumulative installed PV capacity stood at just 22 MW at the end of 2021.

Solar PV in Europe has a capacity factor of 30%. By 2050, 35% of total demand will come from Solar. All other renewable sources remain at 2015 capacities in 2050. Both wind and solar remain variable sources of energy. Albania's National Renewable Energy Action Plan (NREAP) sets forth renewable energy targets till 2020 and in going forward, the NREAP will be superseded by the National Energy and Climate Plan (NECP), which is still to be developed and will set out renewable energy targets to 2030 (figure 2).



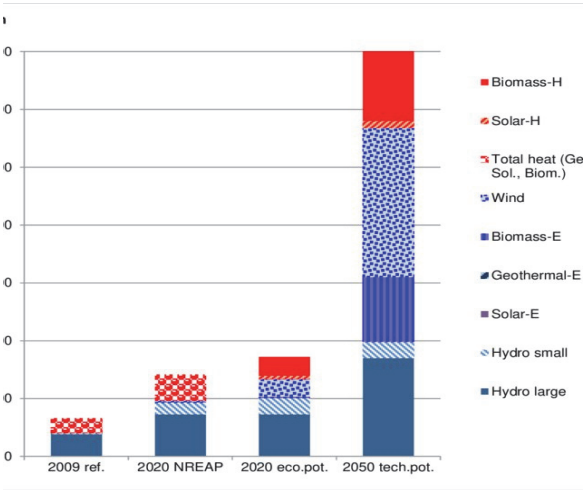


Figure 2. Renewable energy targets

3.3.5 Technical Considerations

When considering the implementation of PV (photovoltaic) technology in Albania, several technical factors should be taken into account. These considerations ensure the efficient and effective deployment of PV systems.

Conducting a comprehensive solar resource assessment is essential to determine the solar irradiation levels and potential of specific locations in Albania. This assessment helps identify areas with high solar energy availability, ensuring optimal placement of PV installations.

Proper system sizing ensures that the PV installation meets the electricity demand requirements. Factors such as the expected energy consumption, available roof or ground space, and solar irradiation levels should be considered when determining the size and capacity of the PV system.

Choosing high-quality PV modules, inverters, and balance of system components is important for system performance and durability. Selecting reliable and certified equipment from reputable manufacturers helps ensure the long-term effectiveness of the PV system.

Planning for grid connection is essential when integrating PV systems into the existing.

3.3.6 Advantages of Photovoltaic Technology

One of the most significant advantages of photovoltaic technology is that it is a renewable energy source (fig.2), which means it can be replenished indefinitely without being depleted. Unlike fossil fuels, which are finite and contribute to greenhouse gas emissions, solar energy[3] is abundant and has minimal environmental impact.

While the upfront cost of installing a photovoltaic system can be high, it has the potential to be cost-effective in the long term. Once a system is installed, the cost of producing electricity is relatively low, as there are no fuel costs and minimal maintenance expenses. In addition, some governments offer incentives, such as tax credits and rebates, to encourage the adoption of solar energy.

PV systems require minimal maintenance, as they have no moving parts and are designed to last for many years. Routine cleaning and inspection of the system can help to maximize its efficiency, but beyond that, there are few maintenance requirements.

PV technology is a clean and sustainable energy source that produces no emissions or pollutants during operation. Unlike fossil fuels, solar energy does not contribute to air or water pollution, and it has minimal impact on natural habitats and ecosystems. This makes it an environmentally friendly alternative to traditional energy sources.

[3] *There is a large potential of solar energy in Albania. Solar radiation is 1.7-2 times higher than in Germany.*

3.3.7 Policy Recommendations

When formulating policy recommendations, it is important to consider the specific context and goals of the subject matter. However, here are some general policy recommendations that could be applicable in the context of PV technology and energy in Albania. Set ambitious renewable energy targets that include specific goals for solar PV installations. Clear and measurable targets provide a framework for planning and investment in the sector, driving the transition towards a sustainable energy system. Consistent and predictable policies, such as feed-in tariffs and power purchase agreements, provide investors with confidence and encourage long-term investments in solar PV projects.

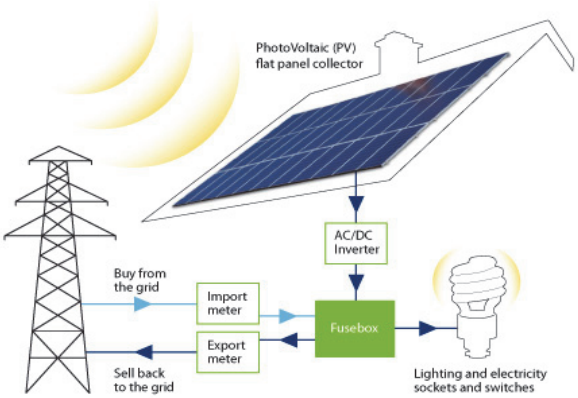
Simplify and streamline the permitting and licensing processes for PV installations. Clear guidelines, standardized procedures, and reduced bureaucracy can accelerate project implementation and attract more investments in the sector. Provide financial incentives and support mechanisms to make PV technology more accessible and financially viable. This can include tax credits, grants, low-interest loans, and subsidies for equipment purchase, installation, and operation of solar PV systems. Allocate funds for research and development in solar PV technology. Supporting research initiatives can drive innovation, improve efficiency, and reduce costs associated with PV installations, making them more affordable and competitive.

Invest in grid infrastructure development to support the integration of PV systems into the electricity grid. Upgrading and expanding the grid capacity, improving transmission and distribution networks, and implementing smart grid technologies can facilitate the smooth integration of solar PV into the energy system. Foster collaboration and partnerships between government entities, private sector stakeholders, research institutions, and international organizations. This collaboration can facilitate knowledge sharing, technology transfer, and joint initiatives to drive the growth of PV technology and address common challenges.

4. Results and Discussions

4.1 The benefits of utilizing photovoltaic technology

Any business that today pays 14 All/kWh for the energy it receives from the Electricity Distribution Operator can significantly reduce its bill, if it were to use solar energy the reduction would generally be between 6-8 All[4]. This would be reflected in a much more economical energy bill. The return on investment takes 5-7 years. If the energy is provided for a more economic price of 9.5 All, as defined for family consumers, the plants have a return on investment in a longer term, but in the end they are feasible, considering that their life expectancy is more than 25 years. If we have a monthly consumption of 979:41kW it corresponds to a price of 1000 All. If in one year we have consumed 8656: 92kWh with a cost of 120,000 ALL we can make a comparison with the energy produced by the panels for one year. We start from formula: *Ee = AHrPH* = 13833*kW.* The cost of the panels mounted in the on-grid system (figure 3) is 8600 Euros.



[4] *1.00 Euro = 111.83277 ALL ; 1 ALL = 0.00894192 EUR*

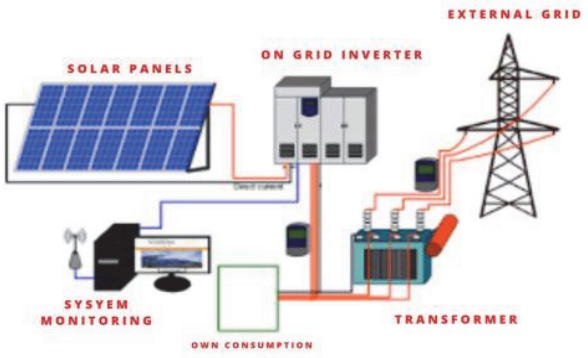


Figure 3. On-grid Solar System Design & Installation

This cost corresponds to a value of 47.7 Euros every month for 15 years of warranty that they have these panels. These panels have a 15-year warranty. In case we have to calculate the consumption and cost of energy for 15 years, launched from the above calculations we have an expenditure of about 1 811 200 ALL .So, starting from the comparison of costs with PV systems, we have about 800,000 ALL savings for 15 years. Let's make an energetic comparison. For one year we consume about 8656:92kW electrical energy. For one year PV generate 13833kW of electricity. Thus we have about 5000kW more to use for one year.

For how many years do these panels cover the investment? To answer the above question, let's start from energy consumption. For one year we are obliged to pay about 120,000 ALL. For in about 8 years we spent approximately 10 million ALL as much as the cost of it panels so approximately 8 years we take out the investment made. Given that the warranty of the panels is 15 years and for 7 years we use them for free. Talking with the energy language, for 7 years we have exactly 96 831 kW free electricity. The cost of an on-grid solar system[5] is lower than other types of solar systems because there are no batteries.

It also generates the highest amount of power compared to other types of solar systems. The minimal maintenance and reduction in monthly power bills ensure the customer gets an ROI of 25 – 30%. With these advantages, an on-grid system is best suited for a customer with stable grid power and minimal power cuts. Other than homes, even educational institutions, industrial units, commercial establishments install an on-grid system as the system can synchronize with diesel generators to provide uninterrupted power.

The average efficiency of photovoltaic (PV) technology can vary depending on several factors such as the type of PV cell technology, the quality of the PV module, and the operating conditions. Currently, the most commonly used PV cell technology is crystalline silicon, which has an average efficiency of around 15-20%. There are other emerging PV cell technologies that offer higher efficiencies such as thin-film PV cells, which can achieve efficiencies of up to 22%.

The efficiency of a PV module also depends on the quality of the manufacturing process and the materials used. High-quality materials and manufacturing processes can result in higher efficiencies. In addition, the operating conditions of a PV module can also affect its efficiency. The efficiency of a PV module decreases as the temperature of the module increases, and the module is exposed to shading or low light conditions. The average efficiency of PV technology is around 15-20%, but there are emerging technologies that offer higher efficiencies. The efficiency can also vary depending on the quality of the manufacturing process, materials used, and operating conditions.

4.2 Strategies for Successful Implementation

Government support and policy development - One of the key strategies for successful implementation of photovoltaic technology in Albania is government support and policy development. The Albanian government can play a crucial role in

[5] *An on-grid system is designed to first allow solar energy to be consumed by the customer. If the customer needs any excess power, it is drawn from the grid. If the customer's energy requirement is lower than power generated from the solar system, excess solar units are exported to the grid.*

promoting the adoption of PV technology by offering financial incentives, such as tax credits and subsidies, to homeowners and businesses that install PV systems. The government can also develop policies and regulations that support the integration of PV systems into the national grid and encourage the development of a thriving solar industry in the country.

Private sector investment - Private sector investment can also be an important driver of the adoption of PV technology in Albania. Investors can finance the installation of PV systems and develop large-scale solar projects, which can help to reduce the cost of solar energy and increase its availability. In addition, private sector investment can lead to the development of a local solar industry, creating jobs and contributing to economic growth.

Education and awareness campaigns - Education and awareness campaigns can help to increase public understanding of the benefits of PV technology and how it works. These campaigns can be targeted at homeowners, businesses, and policymakers, and can include information about the cost savings associated with PV systems, their environmental benefits, and how they can be integrated into the national grid.

Collaborative efforts between stakeholders - Successful implementation of PV technology in Albania will require collaboration between stakeholders, including government, the private sector, and civil society. Collaboration can help to identify common goals, develop shared strategies, and address barriers to implementation. Stakeholders can work together to develop public-private partnerships, promote research and development, and create a supportive regulatory environment for the adoption of PV technology.

4.3 The impact of climate change on Photovoltaic Technology

Climate change can have significant impacts on photovoltaic (PV) technology in Albania, as it can affect the availability of sunlight and temperature, among other factors.

Albania has a favorable climate for solar energy production, with plenty of sunlight throughout the year. Climate change can result in changes in weather patterns, which can potentially reduce the amount of sunlight available in some regions or affect the quality of sunlight. This can result in reduced output from PV systems and can impact their effectiveness.

Another significant impact of climate change in Albania is the increase in temperature. As the temperature rises, the efficiency of PV systems decreases, and their output is reduced. This can potentially limit the effectiveness of PV systems in some regions of Albania and can result in increased maintenance costs.

Extreme weather events such as heavy rainfall, flooding, and high winds can also damage PV systems, reducing their effectiveness and increasing maintenance costs. These weather events may become more frequent and intense as a result of climate change, potentially affecting the lifespan of PV systems in Albania. Finally, water scarcity can also be a challenge for PV systems in Albania. As water is needed for cleaning the modules to maintain their efficiency, water scarcity can potentially limit the effectiveness of PV systems. Climate change can have significant impacts on photovoltaic technology in Albania, highlighting the need for developing resilient and sustainable systems that can adapt to changing climate conditions. It also underscores the importance of taking action to mitigate climate change and reduce its impact on renewable energy systems.

5. Conclusion

In conclusion, the implementation of PV technology in Albania holds great potential for addressing the energy crises, diversifying the energy mix, and promoting sustainable development. Albania has a significant solar resource potential that can be harnessed to generate clean and renewable electricity. The country's current energy situation, policies, and incentives create a favorable environment for the growth of PV installations and projects.

The technical feasibility of PV in Albania is supported by advancements in solar technology, suitable site conditions, and grid integration capabilities. PV systems can be effectively deployed on rooftops and non-agricultural lands, contributing to land use efficiency and minimizing environmental impact. However, careful consideration of technical factors such as solar resource assessment, system sizing, equipment selection, and grid interconnection is crucial to ensure the optimal performance of PV installations.

Economically, PV technology in Albania offers promising prospects. The declining costs of PV systems, coupled with supportive policies and financial incentives, make solar energy an economically viable option. Furthermore, PV installations can contribute to job creation, local investment, and energy independence, fostering economic growth and resilience.

From an environmental standpoint, PV technology in Albania presents significant benefits. By displacing fossil fuel-based electricity generation, PV systems help reduce greenhouse gas emissions, improve air quality, conserve water resources, and contribute to the country's renewable energy goals. While challenges such as land use, end-of-life management, and grid integration need to be addressed, proper planning, monitoring, and mitigation measures can ensure that the environmental impact of PV installations remains minimal.

In order to maximize the potential of PV technology in Albania, policy recommendations are essential. These recommendations include setting renewable energy targets, ensuring policy stability, streamlining permitting processes, providing financial incentives, supporting research and development, investing in capacity building, and fostering collaborations. By implementing these policies, Albania can create a conductive environment for the widespread adoption of PV technology, contributing to a sustainable and resilient energy sector.

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