IOSR Journal of Economics and Finance (IOSR-JEF)
e-ISSN: 2321-5933, p-ISSN: 2321-5925.Volume 15, Issue 3 Ser. 1 (May. – June. 2024), PP 72-79
www.iosrjournals.org

Evaluating Solar Energy Solutions: Installation, Maintenance, and Economic Impact on Boarding Facilities

Shivam Singh Panwar

I. Introduction

Solar power has been steadily growing in popularity over the years. Over time, there have been several significant technological advancements in solar power and solar panel technology. These innovations have resulted in solar power becoming more efficient, cost-effective, and versatile. With these innovations, solar panels are now more common in the economy. Now, many people are replacing their source of power with solar energy, as it is more efficient and much cheaper for long-term usage [1].

Efficiency improvements in solar panels

Over the years, there have been significant enhancements in solar panels. The ability of panels to convert sunlight into electricity has increased, i.e., the rate of conversion of sunlight to electricity has increased, resulting in a higher energy yield. According to the National Renewable Energy Laboratory (NREL), the efficiency of solar cells has improved dramatically over the years.

In 2000, the efficiency record for solar cells stood at approximately 25%.

By the mid-2010s, this figure had risen to around 35%.

Recent laboratory tests have seen efficiency records nearing the 50% mark.

This continual improvement in solar panel efficiency means more power generation per unit area, reducing the space required for solar installations.

1 "India Energy Information." Enerdata, www.enerdata.net/estore/energy-market/india/. Accessed 30 Aug. 2024.

Development in solar cell materials

The development is not only in efficiency but also in the materials used for making solar cells. Traditionally, crystalline silicon cells were used in solar panels, but now new materials are starting to show up and make their place in the solar industry. The two main advancements in the solar industry are:

Thin-film solar cells—these cells are a type of photovoltaic technology that uses very thin layers of semiconductor materials to convert sunlight into electricity. Its layers are much thinner than the traditional silicon wafers used in conventional solar cells, making them flexible and lightweight, allowing for a variety of applications that are not possible with conventional rigid silicon panels. These cells use less semiconductor material than traditional silicon cells, potentially reducing costs. These cells perform better at high temperatures compared to silicon-based cells and can be integrated into building materials (BIPV) such as windows, facades, and roofing materials, providing a more aesthetically pleasing option. Despite having all these advantages, these cells have some disadvantages too. These cells have lower efficiency compared to the conventional crystalline silicon cells, as performance is limited as thickness is decreased due to poor absorption of near band gap light. These cells also use materials such as CdTe, which is toxic and requires careful handling. These cells can be more susceptible to degradation over time, though ongoing research is improving their stability and longevity.

Perovskite solar cells: Perovskite tandem solar cells are a type of advanced photovoltaic technology that improves the efficiency of solar energy conversion by combining two or more layers of various semiconducting materials. These cells combine traditional silicon with cutting-edge perovskites and absorb different wavelengths of light compared to silicon cells, allowing them to utilize more of the solar spectrum and produce more electricity per cell1. While silicon-based cells have a technical efficiency limit of below 30%, perovskite tandem cells have already exceeded 33% efficiency in the lab.

Advances in solar battery storage

The improvements in the solar panel technology don't stop with the panels themselves. Another important development is the introduction of solar battery storage technologies that are more economical and efficient. When the sun isn't shining, the excess power produced by the solar panels can be stored in these batteries and used later. Some of the key features of these advances include:

Increased capacity: newer batteries designed can store more energy while taking up less space, allowing people to use solar energy during nights, when the weather is cloudy, or when it's raining.
Decreased costs: with new designs of solar batteries coming up in the market, the popularity of these batteries has increased as they are comparatively cheaper than the older ones, making them more budget-friendly and affordable for average consumers.

Solar Tracking Technology

A very common drawback of solar panels is that they are not able to generate the same amount of solar energy throughout the day because of the change in the position of the sun. To fix this issue, solar tracking technology has been made. Solar tracking panels are photovoltaic systems mounted on structures that follow the sun's movement across the sky. Unlike fixed solar panels that remain stationary, these systems adjust their position throughout the day to maintain optimal alignment with the sun. This maximizes the amount of sunlight captured and thus the energy generated. This technology helps in increasing energy production by maintaining optimal alignment with the sun and makes better use of space, as more efficient energy capture can reduce the number of panels needed for a given energy target, potentially saving space. The only issue with these solar tracking panels is that they have high installation and maintenance costs. These trackers are more expensive than fixed mounting systems due to the additional components and complexity, and moving parts and motors can require more maintenance and are more prone to mechanical failures. The setup process is more complex and may require specialized expertise, which costs more, but with the recent advancements, the costs are getting lowered.

Bifacial Solar Panels

Bifacial solar panels are one of the latest developments in solar panel technology. These panels are photovoltaic panels that are designed to capture sunlight from both their front and back sides. Unlike traditional solar panels, which have a single light-absorbing surface, bifacial panels are designed to harness solar energy from direct sunlight hitting the front side and reflected or diffused light hitting the rear side. Bifacial panels typically have a transparent back sheet, allowing light to pass through to the rear solar cells. Some of the panels have a dual-glass mechanism, where solar cells are sandwiched between two layers of glass. By capturing additional reflected light, bifacial panels can generate more electricity compared to traditional monofacial panels, as in their case a lot of sunlight is not captured by them, and it gets wasted. The efficiency gained through these bifacial panels depends on the installation environment and how much light the rear side can capture. They can be mounted on various types of surfaces, including rooftops, ground mounts, and specialized tracking systems that optimize their exposure to sunlight. Bifacial solar panels are particularly effective in locations with high albedo (reflectivity), such as snowy areas, sandy deserts, or highly reflective surfaces like white rooftops. While the initial cost of bifacial panels can be higher than that of traditional panels, the potential for increased energy output can make them more cost-effective over time. Installation may require careful consideration of the surface and angle to maximize reflected light capture. The dual-glass construction often used in bifacial panels can enhance their durability and lifespan, making them a robust choice for various environmental conditions. The disadvantage of bifacial panels is that they can be more expensive than traditional solar panels. To operate efficiently, bifacial panels require specific conditions. They need a suitable reflective surface beneath them that can reflect light towards the panels. They require special mounting systems and greater distance from the ground. These types of special mounting systems are generally more expensive compared to traditional solar panels or monocrystalline panels. Both sides of the panel may need to be cleaned regularly, which can increase the maintenance costs.

Working on a solar panel

Traditional solar panels convert sunlight into electricity by using the photovoltaic effect. They are made of semiconductor materials, usually silicon, which absorbs photons from sunlight. This absorption excites electrons, freeing them from their atomic bonds and creating electron-hole pairs. The internal electric field of the solar cell, created by a junction of p-type and n-type silicon, directs these electrons towards the n-type side and holes towards the p-type side. Metal contacts on the cell collect the free electrons, which flow through an external circuit as electric current, generating usable electric power. The combination of current and voltage produced by these cells determines the overall power output of the solar panel. Multiple cells are connected to form a panel, and multiple panels can be connected to form larger solar arrays for increased energy production. One major factor on which the efficiency depends is the sunlight captured by the panel, but there are cases when the panels are not able to capture the amount of sunlight they are capable of capturing. This issue can be resolved by adjusting the tilt and orientation of the solar panels. This can drastically impact their exposure to sunlight. In winter, the panels are not able to harness much sunlight as the sunlight path in winter is much lower in the sky, so tilting the panels to a steeper angle can help capture more sunlight.

Rooftop Solar Scheme, or the PM Surya Ghar Muft Bijli Yojana [1].
Under the Rooftop Solar Scheme, the government will provide the below subsidies for installing solar panels: For up to 2 kW, Rs. 30,000 per kW. For additional capacity up to 3 kW, Rs. 18,000 per kW. Total subsidy for systems larger than 3 kW: Maximum Rs. 78,000

Solar Schemes Solar Off-grid
Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan (PM KUSUM)
New Solar Power Scheme (for PVTG Habitations/Villages) under PM JANMAN.

Importance of solar power

As a renewable source of power, solar energy has an important role in reducing greenhouse gas emissions and mitigating climate change, which is critical to protecting humans, wildlife, and ecosystems. Solar energy can also improve air quality, reduce water use from energy production, and provide ecosystem services for host communities through carbon sequestration, pollination, and ground and stormwater management. Because ground-mounted photovoltaics (PV) and concentrating solar thermal power (CSP) installations require the use of land, sites need to be selected, designed, and managed to minimize impacts to local wildlife, wildlife habitat, and soil and water resources. [2]

2 Solar, Citizen. "Government Subsidy on Solar Panel in India 2024." Citizen Solar, 27 May 2024, www.citizensolar.com/subsidy-on-solar-panel/

3 Yackery, Alex. "The Importance of Solar Energy." Venture Solar, 16 Feb. 2017, venturesolar.com/blog/the-importance-of-solar-energy/

Cost of Installation and Maintenance
The initial cost of installing a solar energy system includes the price of solar panels, inverters, mounting structures, and associated components. For a typical solar installation of 1 kWh capacity, the costs vary depending on the type of solar module chosen:
Monocrystalline Panels: These panels are known for their high efficiency and sleek black appearance. They typically generate around 700 watts and are priced at approximately Rs. 52,000 per kWh. Monocrystalline panels are favored for their space efficiency and high performance, particularly in areas with limited roof space.
Polycrystalline Panels: Slightly less efficient than monocrystalline panels, polycrystalline panels are blue and generate between 300 and 375 watts. They are generally used for domestic consumption and cost around Rs. 50,000 per kWh.
Bifacial Panels: These panels offer the advantage of generating power from both sides, allowing them to capture reflected sunlight in addition to direct sunlight. Bifacial panels are priced at approximately Rs. 55,000 per kWh and are often used in larger installations where maximizing energy capture is crucial. The ground beneath these panels is often painted white to enhance light reflection, further boosting efficiency.
Maintenance is another critical aspect of solar energy systems. Regular cleaning of solar panels is necessary to ensure optimal performance, as dust and debris can significantly impact their efficiency. Maintenance costs are relatively low compared to the initial installation expenses, but they are essential for the long-term reliability and effectiveness of the system.

Structural Considerations

The placement of solar panels is influenced by structural factors to maximize sunlight absorption. Panels are typically installed at an elevated height to capture sunlight efficiently. However, there is a balance to be struck between height and stability. Raising panels too high can expose them to potential damage from wind pressure. The cost of increasing the height of solar panel installations is around Rs. 4,000, a consideration for homeowners and institutions with limited roof space.

Sun-Tracking Devices

To further enhance the efficiency of solar installations, sun-tracking devices can be employed. These devices adjust the orientation of solar panels to follow the sun's path throughout the day, optimizing energy capture. Although effective, sun-tracking systems are complex and require significant maintenance due to their reliance on motors. They are more commonly used in large-scale solar farms rather than residential or small commercial installations.

Solar Energy in Educational Institutions

In addition to theoretical analysis, I interviewed students from various schools to gather insights into how solar technology is used on their respective campuses. Three students from different institutions provided valuable information about solar panel usage.

Emerald Heights, located in Indore, Madhya Pradesh, has made solar energy a cornerstone of its daily operations. Approximately 90% of the energy used for lighting, ventilation, water heating, and other day-to-day activities is generated through solar panels. With a sprawling 100-acre campus and around 1,000 students, the school consumes an average of 900 kWh of electricity per day, with the cost ranging from Rs. 5.50 to Rs. 7.50 per kWh. This results in a daily electricity expenditure of Rs. 4,950 to Rs. 6,750. However, due to seasonal appliance usage, the cost can vary throughout the year. The adoption of solar energy has significantly reduced their energy costs.[1]

Mayo Girls School in Ajmer, Rajasthan, accommodates approximately 800 students and uses solar power for basic operations like powering fans, water heaters, and lights. Falling under the commercial electricity tariff category, the school's energy consumption is around 24,000 kWh per month, costing Rs. 171,500, including fixed charges by Ajmer Vidyut Vikrant Nigam Ltd. (AVVNL). Solar panels have greatly decreased this expense.

Hopetown Girls School in Dehradun has integrated solar energy to offset its electricity costs. The school uses about 750 kWh of electricity daily, amounting to Rs. 4,267.50 per day and Rs. 128,025 per month at Rs. 5.69/kWh. With a campus covering 50 acres and approximately 500 students, solar panels have helped reduce the overall energy costs of running a boarding school.

All these schools have managed to lower their electricity costs substantially by embracing solar technology. I, too, am a student of Welham Boys School, Dehradun, and am conducting this research as part of the Department of Economics to explore the economic feasibility and sustainability of solar power in educational institutions.

[1] Interview with students

Energy costs and Buyback rates

In Dehradun, the cost of electricity is approximately Rs. 6 per unit. The government offers a buyback rate of Rs. 4 per unit for electricity generated from solar panels. This disparity in rates influences the economic feasibility of solar installations, as it affects the return on investment for solar energy systems.

Welham Boys' School: Energy Consumption and Solar Potential

Welham Boys' School, an educational institution located in Dehradun, presents a unique case study for the application of solar power. The school's energy consumption profile includes the use of ceiling fans, fluorescent tube lights, and air conditioning vents. In a typical classroom, there are around six fans, eight tube lights, and one air conditioning vent. Fans consume approximately 80 watts per hour and operate for about 8 hours a day, resulting in a daily consumption of 0.64 kWh and a monthly consumption of 19.2 kWh. Tube lights, which vary in efficiency, are used for around 7 to 8 hours daily, while air conditioning vents contribute significantly to the school's overall energy consumption.

Several hostel buildings within the school also utilize solar panels, reflecting a growing trend toward renewable energy adoption in institutional settings. By assessing the school's energy needs and the potential for solar power to meet these demands, this paper aims to provide a comprehensive understanding of the practical benefits and challenges associated with solar energy in an educational environment.

The current cost of electricity for every room per day.

Component	Quantity (hours)	Quantity(watts)	Price (□/day)
Fans	8	80	3.840
Lights	8	40	1.920
AC	--	--	1.000
Total	--	--	6.760

Proposed cost with solar panels for every room per day.

Component	Cost □/day
Maintenance	500

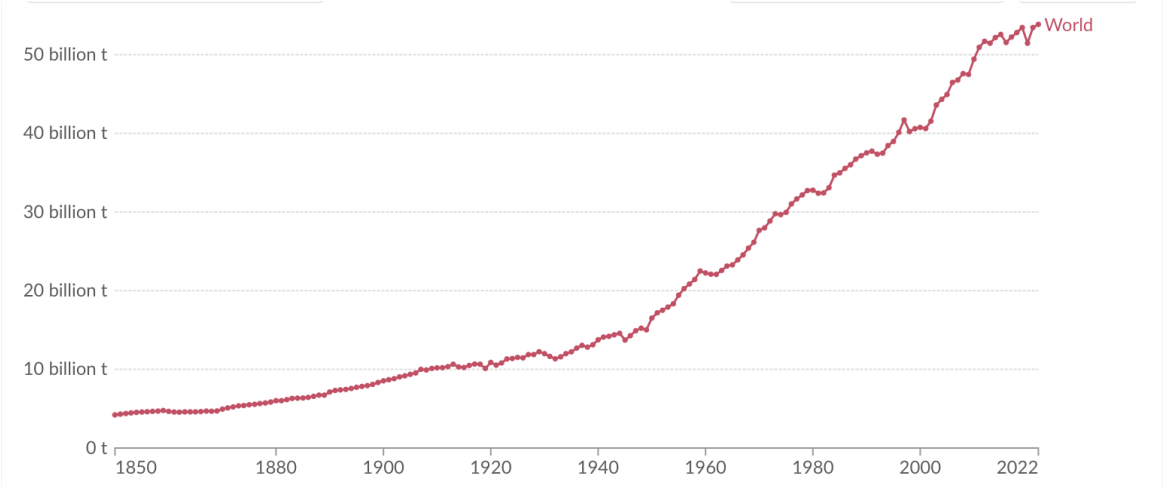
Advantages of Solar Energy

1. Solar is a Renewable Energy Source [1]

As the name suggests, solar power is a resource that never runs out. Unlike fossil fuels, the process of energy production in solar power is much simpler and easier. In the case of the production of solar energy, the sunlight gets converted into electricity. This conversion of sunlight into electricity happens through photovoltaic (PV) panels. These panels contain cells that can capture the sunlight's energy. This energy generates electrical charges that move around the cell, causing electricity to flow. Another big factor that makes solar energy much more attractive than coal, oil, and natural gas is the significant difference in emissions. Fossil fuels are one of the world's

largest contributors to the generation of greenhouse gases, and over the years the generation of greenhouse gases due to fossil fuels has increased. The graph below shows the data for 100 years.

[1] **Igini, Martina. "The Advantages and Disadvantages of Solar Energy." Earth.Org, 4 Mar. 2024, earth.org/what-are-the-advantages-and-disadvantages-of-solar-energy/.**



Renewable energy sources are not only cleaner but also cheaper and easier to produce than any fossil fuel.

2. Solar energy is Immensely Abundant

There is no doubt in saying that solar is the most abundant energy source on the planet in history and even in the present. Despite its abundance in nature, our scientists are still trying to make solar panels efficient for better energy production. Throughout the years, many innovative technologies have come up that could allow us to depend entirely on solar for the rest of our existence. According to a study by the US Department of Energy, a tiny fraction of the sunlight we get every day can provide a huge amount of energy. They also say that an hour and a half of sunlight that reaches the planet's surface generates enough power to meet all of humanity's energy consumption for an entire year.

Disadvantages

Solar Energy is Weather Dependent

An undoubted and unavoidable disadvantage of solar energy is that it is not equally beneficial and efficient for all around the world. Through the advancements that we have made in the field of solar panels, the panels can generate solar power on a cloudy day, but still some level of daylight is required in order to harness the sun's energy. The amount of energy that can be produced varies greatly depending on many factors, such as the amount and quality of direct sunlight that the panels receive and the size, number, and locations of the panels themselves. Thus, in countries that receive limited sunlight throughout the year, alternative renewable resources like geothermal energy and hydropower might work better. In areas such as Iceland, which has little sunlight and wind, it is beneficial for these areas to use multiple types of energy at the same time for better efficiency. Suppose if sunlight makes 25% of the energy, the other resources can be used to make up for the 75%.

Expensive Energy Storage [1]

The huge installation cost of solar energy systems has been an issue for a long time now. The solar panels were already expensive to some, but these solar batteries are making the situation worse. The cost of these panels depends on the materials used in their manufacturing and how much power they can generate. Solar cells are expensive because they need some rare materials like copper, indium gallium selenide, and cadmium telluride for manufacturing. This very reason keeps the prices of solar panels and batteries high. Over the years, the installation costs of the solar panels have been reduced, decreasing their overall cost. Installing solar panels at home may seem like a great way to save up money for many, but not for all. Some people live alone in a small space; for them, using electricity from traditional means is more cost-efficient than buying solar panels and batteries. In India, the government is providing heavy subsidies to bring down the cost of solar panels, but in the end, this would just add to the burden of taxpayers. Many people in the country, just to save up money, use energy from normal energy sources at night and solar energy during the day. To these people, this seems to be a better option than buying expensive solar batteries. In India, solar batteries from popular brands such as Luminous cost around $27,000 for a 165-watt battery, which works for around 150 amp hours (but that is up to the usage).

[1] Buy High-Quality Inverters & Batteries Online at Luminous, www.luminousindia.com/. Accessed 30 Aug. 2024.

Advantages of fossil fuels

1. Fossil fuels are a technology that is globally developed. There are numerous technologies available to us because of the presence of fossil fuels, as there was a time when there was no other source of energy other than fossil fuels. Even today, 84% of the energy produced is from fossil fuels. Although this fuel source is often thought of as providing transportation needs, many of the products, like computers and mobile phones, that we use every day contain items that were manufactured thanks to fossil fuel technologies. Even renewable fuels have a foundation built on fossil fuels.

2. Fossil fuels still have plenty of availability. Even after the rigid use of fossil fuels every day by households and producers, new fossil fuel resources continue to be found annually and often in amounts that are beyond any prediction that could be made. In 2013, up to 233 billion barrels of oil were discovered in the Australian Outback. Additional development opportunities exist for tar sands oil, shale oil, and natural gas. Fossil fuels are indeed a finite resource, but there is still enough resource present beneath the earth that a century ago could use the present known resources without much difficulty.

Disadvantage of fossil fuels

1. Fossil fuels combust to create an acidic environment. The heavy usage of fossil fuels by producers without condensing technologies leads to an environment that is very acidic in nature. This acidity is not something that can be overlooked, as it is very much capable of changing ocean environments, altering how crops can grow, and may even lead to a higher risk of drought and famine. Many ecosystems present on Earth are very sensitive to such changing conditions. Hence, continued fossil fuel use without any necessary preventive measures could lead to unpredictable and extremely negative consequences.

2. Fossil fuels can damage the environment through human error. During the transportation of these Fossil fuels, there is always a possibility that these resources may spill out, which could create some very serious environmental damage as the product spills out. This sort of accident is mostly seen in the case of petroleum products. Some of the accidents can be so dangerous that the flora, fauna, and humans in mass could die. Such cases were the Exxon Valdez spill and the Deepwater Horizon spill in the U.S. Even regular wear and tear, if not properly maintained, can lead to a higher risk of a leak occurring. Apart from the risk of poor handling of these resources, even the usage of these fuels (like burning them) can have a negative direct impact on human beings, causing diseases like lung cancer, infection, and asthma. These resources are neither eco-friendly nor safe to use. Another related disadvantage of using fossil fuels is that it has a direct impact on the health of human beings. Potentially, fatal diseases or illnesses such as lung cancer, infection, and asthma have been directly linked to the pollution caused by the burning of fuels. It is neither environment-friendly nor safe to use. According to the World Health Organization (WHO), 7 million premature deaths annually are linked to air pollution. The high levels of air pollution can adversely affect people's lungs and trigger asthma. Likewise, every year millions of children die due to pollution-related diseases. People who live in areas with a large amount of traffic are at high risk.

II. Limitations and their solution

Even though there have been various advancements in the field of solar panels and energy, some limitations are still present. Some of the very common limitations are the usage of solar panels during the winter season or at night. The issue of the usage of solar panels during the winter and night can be solved by the usage of solar batteries. These batteries are easily available on the market, but the cost is a bit high for some people. The batteries are designed to store whatever amount of sunlight is captured by the panels during the day for later use. In winter, the amount of sunlight captured by these panels is low. This can be solved by adjusting the tilt and orientation of the solar panels. Doing just this can significantly impact its performance. In regions with significant seasonal variations, it's advisable to tilt the panels to a steeper angle during the winter months. This adjustment helps the panels capture more sunlight when the sun is lower in the sky, optimizing energy production. For areas where snowfall happens, it is advisable to regularly clean and maintain the screen of the solar panels, as most of the time, there is snow or fog on the screen of the panel. For this, panels with cold weather technology have been made that work well in these types of weather conditions.

Even when people install solar batteries, there is still a possibility that the power in the battery may run out. For example, if there is a very cloudy day accompanied by rain, then the panels by no means would be able to produce electricity. This would be very problematic for the user, as he won't have any electricity to use and would have to wait for the next day for the weather to clear up (which can't be guaranteed) for batteries to charge up again. To fix this sort of issue, the user can use the technique of grid integration. Here, till there is power left

in the batteries, the user can use it, and when it runs out, they can use the power from the grid. The only drawback of using this is that he would have to pay for the energy used from the grid.

Feasibility

Dehradun, Uttarakhand, India, is a pretty good spot for generating solar energy all year round. The amount of electricity you can produce from solar panels changes with the seasons, but even in winter, you'd still get a decent amount. In simple terms, for every kilowatt (kW) of solar panels installed at this location, you could expect to generate about 5.73 kilowatt-hours (kWh) of electricity per day in summer, 6.67 kWh/day in spring, 5.07 kWh/day in autumn, and 4.40 kWh/day in winter. [1] The best time to generate solar power at this location would be during spring, when the sunlight is most abundant and direct, resulting in the highest daily output of around 6.67 kWh/kW. To make the most out of your solar panels throughout the year at this location, they should be installed at an angle facing South about 28 degrees from the horizontal level—that's because it maximizes exposure to sunlight over a day as well as across different seasons.

However, there might be some local factors that could affect how much electricity your panels can produce. For example, Dehradun has a monsoon season, which may result in cloudy skies, reducing sunlight availability or heavy rainfall, and potentially damaging equipment if not properly protected. Preventative measures such as weather-resistant panel installations and regular maintenance checks are recommended to ensure greater energy production despite these environmental challenges. Also, the installation site should ideally have minimal shade or shadow falling on it, especially during peak sun hours, i.e., between the morning and afternoon periods when sun rays are strongest and most direct, which will help maximize energy production from these PV systems.

6 Robinson, Aaron. "Calculate Your Optimal Solar Panel Tilt Angle: A Comprehensive Guide." profileSOLAR.Com, profilesolar.com/calculate/solarpaneltiltangle/. Accessed 30 Aug. 2024.

III. Conclusion

In conclusion, solar energy presents a sustainable and increasingly efficient solution for addressing energy demands, particularly in locations like Dehradun, where ample sunlight is available throughout the year. The advancements in solar panel technology, including improvements in efficiency, material usage, and innovative features such as solar tracking and bifacial panels, have significantly enhanced the potential of solar power as a renewable energy source. Additionally, government subsidies and schemes further incentivize the adoption of solar energy, making it more accessible to institutions and households alike.

However, challenges remain, particularly in terms of initial installation costs, weather dependency, and energy storage solutions. While solar batteries and grid integration offer ways to address these limitations, they may not be affordable for everyone. Overall, with proper planning, including optimizing the orientation and maintenance of panels, solar energy can be a viable long-term investment for reducing electricity costs and contributing to environmental sustainability.

By incorporating solar power into institutional settings such as Welham Boys' School, significant savings can be achieved while also promoting the use of clean energy and setting an example for renewable energy adoption in educational environments.

Appendix

Interviewer: Thank you all for joining me today to discuss how solar energy is used in your schools. Let's begin with an introduction. Could each of you introduce yourselves and tell us a bit about your school's use of solar energy?

Student 1 (Emerald Heights): Hi, I'm xxxxx, and I study at Emerald Heights International School in Indore, Madhya Pradesh. Our school has fully embraced solar energy. About 90% of the energy we use for daily activities comes from solar power, including lighting, ventilation, water heating, and other needs across the campus. The school is pretty large, spread over 100 acres, and it houses around 1,000 students.

Interviewer: That's impressive. Could you tell me how much energy your school uses on average and what the costs are?

Student 1: On average, we use about 900 kWh of electricity per day, and the cost of electricity ranges between Rs. 5.50 and Rs. 7.50 per kWh. This comes to around Rs. 4,950 to Rs. 6,750 per day. Of course, this changes a bit depending on the season—some appliances, like heaters, are used only in the winter, so the costs can go up during certain times of the year.

Interviewer: That's a significant amount of energy. Have you noticed a difference in costs since the installation of solar panels?

Student 1: Definitely. The costs of running the school have gone down quite a bit since the installation. Plus, we're doing our part for the environment, which is a big deal for the school community.
Interviewer: Great to hear! Now, let's move on to Mayo Girls School in Ajmer. Can you introduce yourself and share how solar energy is used at your school?
Student 2 (Mayo Girls): Hi, I'm xxxxx, and I go to Mayo Girls School in Ajmer, Rajasthan. Our school uses solar energy mainly for basic daily activities like powering fans, water heaters, lights, and classrooms. We have around 800 students living on campus.
Interviewer: How much electricity does your school use, and what are the rates in your area?
Student 2: We use about 24,000 kWh of electricity per month. Electricity rates for schools in Ajmer fall under the commercial category, and the rates are around Rs. 7.15 per kWh. There's also a fixed charge of Rs. 250 per KVA of monthly billing demand. In total, the school's electricity costs come to around Rs. 171,500 per month, which includes all the fixed charges.
Interviewer: Have the solar panels made a noticeable impact on your school's energy costs?
Student 2: Yes, the installation of solar panels has reduced our electricity expenses significantly. The school's administration is really happy about the long-term savings, especially considering the high fixed charges.
Interviewer: That's great to hear. Now, let's hear from xxxxx at Hopetown Girls School in Dehradun. How is solar energy used at your school?
Student 3 (Hopetown Girls): Hi, I'm xxxxx, and I study at Hopetown Girls School in Dehradun. Our school is spread over 50 acres, and we have about 500 students. Like the other schools, we use solar energy for our daily operations, mainly for lighting, heating water, and powering fans.
Interviewer: How much electricity does your school use, and what are the costs involved?
Student 3: On average, we use around 750 kWh of electricity per day, and the cost of electricity is Rs. 5.69 per kWh. That comes out to about Rs. 4,267.50 per day or Rs. 128,025 per month.
Interviewer: Have you noticed any differences in cost after the school started using solar panels?
Student 3: Yes, it's helped reduce the overall electricity costs. The school has been able to save a lot of money each month, and that's important because running a boarding school can be quite expensive.
Interviewer: It's clear that all of your schools have benefited from the switch to solar energy. Thanks for sharing your insights. Before we wrap up, is there anything else you'd like to add about the importance of using solar energy in schools?
Student 1 (Emerald Heights): I think the most important thing is that we're reducing our carbon footprint. Solar energy is a great way to save on costs and help the environment at the same time.
Student 2 (Mayo Girls): I agree. Schools use a lot of energy, especially boarding schools like ours, so it makes sense to go solar.
Student 3 (Hopetown Girls): Absolutely. Plus, it sets a good example for students. We see first-hand how renewable energy works and how it benefits us, which makes us more aware of environmental issues.
Interviewer: Thank you all for your time and for sharing your experiences. It's been wonderful to hear how solar energy is making a difference in your schools.

Bibliography

[1] National Renewable Energy Laboratory (NREL). "Efficiency of Solar Cells." Accessed via NREL.gov.
[2] Ajmer Vidyut Vikrant Nigam Ltd (AVVNL). "Tariff Schedule for Electricity Rates in Ajmer." Published by AVVNL, latest schedule.
[3] U.S. Department of Energy. "Solar Energy Potential and Conversion." Accessed via energy.gov.
[4] Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan (PM KUSUM). Government Scheme Details. Ministry of New and Renewable Energy, Government of India.
[5] World Health Organization (WHO). "Air Pollution and Health." WHO Global Report on Premature Deaths and Air Pollution.
[6] Welham Boys' School, Dehradun. "Energy Consumption Profile and Solar Power Usage." Internal School Report.