DISTRIBUTING THE POWER OF THE SUN

MULTIFOLD CLIMATE CONTRIBUTION IN A SINGLE ACTION

AN INSIGHT TO THE SPDU IMPACT IN THE RESIDENTIAL SECTOR

PROTOSTAR®

Democratizing Solar for all

2023

Democratizing Solar. For All.

OUR FOCUS

Protostar Technologies Private Limited is dedicated to delivering sustainable technologies, primarily renewable energy, to individual units in multi-storey buildings that have a shared roof or other common areas, which include residential and office complexes, malls, industrial facilities, and more. The company achieves this through its exclusive and proprietary technology.

THE PROBLEM

Currently, the Solar Photo Voltaic (PV) systems being installed on multi-storey buildings are typically installing s to power common loads and areas, rather than individual units, due to the high installation costs and physical limitations making it impractical, or even impossible for most cases.

As a result, a significant portion of the rooftops remain unused, causing adverse effects on various aspects, from the building tenants to broader national-level impacts.

OUR MISSION

Currently, only High Net Worth Individuals (HNIs) and Commercial establishments have the privilege of installing Solar PV Systems to meet their electricity needs. Unfortunately, the current Solar infrastructure does not extend this energy independence to individual properties that share a common roof.

OUR THREE TIER IMPACT

BENEFIT TO SOCIETIES

BENEFIT TO DISCOM

BENEFIT TO THE NATION

Our mission is to make renewable energy accessible to the masses at affordable rates. By employing first principles thinking and innovative approaches, we have developed a unique and state-of-the-art solution that has the potential to reduce millions of tons of carbon emissions. This is achieved by efficiently distributing power generated from shared/common areas into individual premises.

Our commitment to environmental improvement drives us to continually enhance our impact. Thanks to our proprietary technology, we are on the verge of democratizing solar energy for all, bringing sustainable power to every home or commercial establishment.

PROTOSTAR'S SPDU

FEATURES OF THE *SMART POWER DISTRIBUTION UNIT (SPDU)*

Fixed Power Limit to Individual Units:
Central to SPDU's design is the allocation of fixed power limits to each unit, be it a flat or office. This ensures a balanced distribution of solar power. In cases where a unit's solar quota is exhausted, power is smoothly sourced from the unit's DISCOM meter.

Democratic Solar with Low-Cost Installation:
Every participant within the SPDU ecosystem becomes a vital stakeholder. The unified system approach offers a cost-effective alternative to multiple individual systems, streamlining installation, and enhancing system reliability.

Flexible Time: With its provision to set daily or monthly solar kWh cycles, SPDU demonstrates adaptability with a built-in real-time clock along with the capability of active synchronization of RTC with local time.*

Easy Installation:

- ***Retrofitting in Existing Buildings:*** SPDU stands out with its capability to be effortlessly retrofitted into existing infrastructures without necessitating any internal wiring modifications, where the installation requires work only in the meter rooms.
- ***New Construction:*** For real estate developers, the SPDU system presents a twofold advantage. Preplanning for this system can yield significant cost savings, both in terms of labor and components. Additionally, integrating SPDU can become a unique selling point, aiding in sales while also ensuring adherence to environmental compliances.

Monitoring, Control and Safety: Capability to monitor, control and troubleshoot each SPDU*. The SPDU also features integrated safety mechanisms against power irregularities, serving as an added protective layer between the utility and the connected property.

Future-Proofing: Beyond current energy solutions, the SPDU technology is designed with the future in mind. The hardware, already capable for smart inter-unit power distribution, underscores its potential for evolving with the energy landscape.*

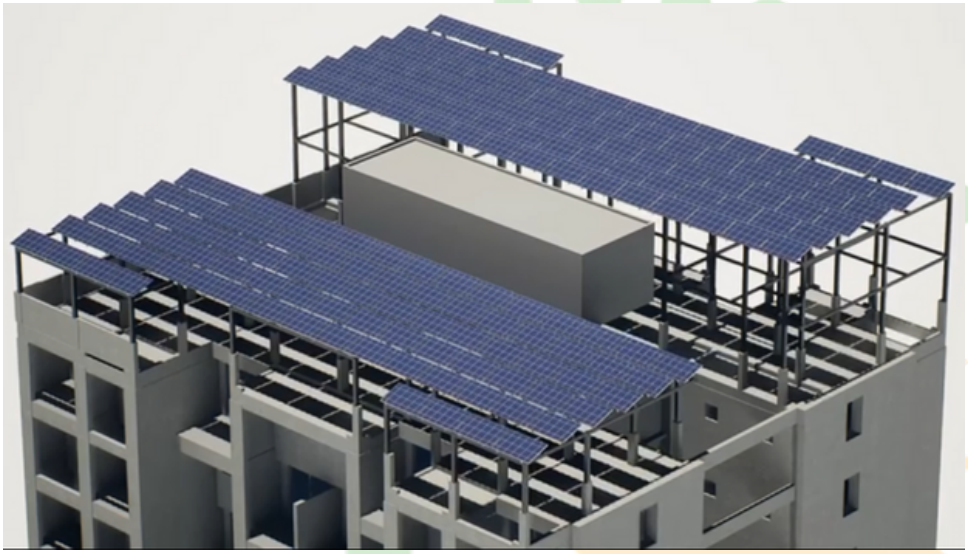
**Requires Feature Subscription (v2)*

As the global focus shifts to renewable energy, especially Solar Power, the transisition requires advanced technologies to ensure optimum utilization. Protostar's **Smart Power Distribution Unit (SPDU)** technology stands as a beacon in this context.

This document explores the **THREE-TIER IMPACT** of the SPDU technology, spanning from direct user and societal benefits to broader implications at the grid, and national scales.

BENEFIT TO SOCIETIES

In a typical building that has a non-functional empty roof space, the roof is exposed to direct sunlight leading to massive heat gain for the entire building, leading to more cooling using inefficient air-conditioners, that further generates more carbon emissions, which leads to higher ambient temperatures, which leads to more energy being used for air-conditioning, resulting in a catastrophic negative feedback loop *[1]*. This can be avoided by shading the entire terrace with a large Solar PV System and then efficiently distributing the excess power generated to apartments using Protostar's SPDU technology.



By covering the entire terrace, the solar panels prevent direct contact between sunlight and the terrace floor, effectively eliminating the roof slab's role as a thermal battery. As a result, the building and its occupants experience reduced heat gain, leading to lower power consumption for cooling and decreased costs for end users. This concept is known as Passive Cooling, which also significantly contributes to reducing the building's carbon footprint *[2][3]*.

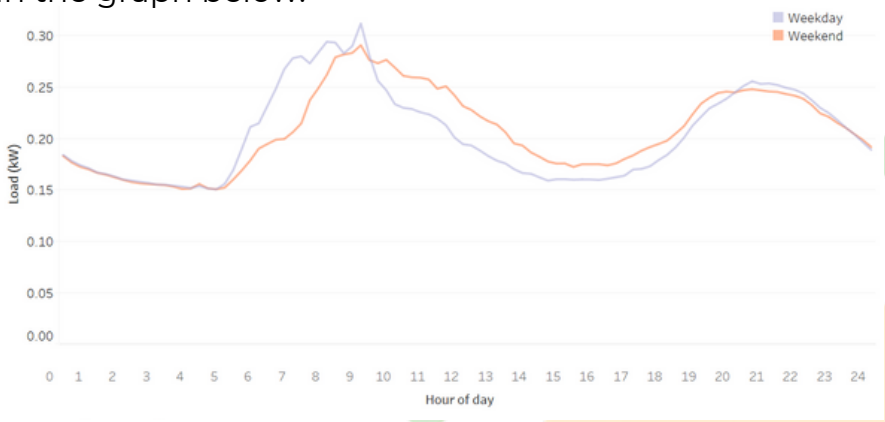
Additionally, the panels' shading effect mitigates cracks in the waterproofing layer by minimizing temperature differentials (ΔT) across the day and night, thus reducing expansion and contraction stresses that lead to cracks *[4][5]*. Moreover, during monsoon seasons, direct rainwater impact can exacerbate minor cracks caused by such thermal variations, accelerating weathering. Full rooftop coverage shields the waterproofing layer from these factors, substantially elongating its lifespan, hence diminishing the residents' concerns over maintenance troubles and costs related to water seepage.

By installing rooftop Solar PV system, not only do we generate clean electricity to reduce energy bills , but we also unlock valuable real estate by transforming the shaded space under the elevated solar panels into a functional and recreational area for residents *[6]* and replacing any Solar Hot Water systems that block substantial roof space. Although not factored into ROI calculations, the intrinsic value of this shaded area outweighs the capital cost of the entire Solar PV System.

It has been observed by our team that most residential buildings, except for the narrow high-rise ones, typically possess sufficient rooftop area to accommodate Solar PV systems that can fulfill anywhere between 40% to 100% of their total energy requirements. If a substantial number of communities embrace rooftop solar, they can not only decrease their energy expenses and carbon emissions but also contribute to substantial positive environmental and ecological change in their cities and, on a broader scale, the world.

BENEFIT TO DISCOM

Most Electricity Distribution Companies (DISCOM) face energy shortages during peak load periods in the day, primarily due to the high energy demand from industries and commercial buildings that rely on heavy equipment, machinery, and air-conditioning *[8]*. To meet this demand, they resort to using highly polluting peaker plants *[9]*. On the other hand, residential buildings experience considerably lower energy demands in midday, during maximum solar irradiance, as majority occupants are typically out of their premises, as seen in the graph below.



Typical Energy Consumption Pattern by a Residential Consumer in Pune [7]

By fully outfitting their vacant rooftop spaces with Solar PV Systems, these Residential Buildings could produce additional electricity that could be channeled back into the grid. This extra power generation can help DISCOMs during times of high energy demand. Essentially, these rooftop Solar PV Systems can function as sizable, decentralized power plants, catering to local energy needs. This can alleviate the load on DISCOMs, allowing them to focus their energy supply towards commercial and industrial consumers, who typically have heavier energy requirements. *[10]*

As Residential Rooftop Solar PV Plants export excess electricity as units (kWh) through the Net Meter, DISCOMs can capitalize on this surplus generation. During daytime, DISCOMs have the opportunity to sell the excess power to commercial establishments and industries at higher Time of Day (TOD) rates. In turn, the DISCOMs can compensate and return the exported power back to residential communities during the night when their energy demand is higher, and the cost of electricity production for DISCOMs is at its lowest.

As previously stated, the shading caused by the Solar PV Plant on the roof effectively reduces heat gain inside the building. This reduction in heat gain leads to decreased air conditioning load for the residents, resulting in lower energy bills. Moreover, this reduction in air conditioning load, which is typically the highest load in buildings, particularly during summer, aids DISCOMs in managing loads from large corporate offices, malls, IT parks, etc., effectively during peak hours of high demand in the daytime.

Direct generation and immediate utilization of power from rooftops also minimizes losses during long-distance transmission of electricity, loss due to ambient heat, and at the transformer level when stepping up and down power *[10]*.

With the ongoing and rapid increase in Electric Vehicle (EV) adoption, the rising demand for electricity poses a significant strain on India's already overloaded grid. Charging EVs during daytime, particularly in summers, exacerbates the grid's stress *[11]*. Furthermore, the true carbon offsetting advantage of EVs can only be realized when they are charged using renewable energy *[12]*. In this context, Residential Solar PV Systems can be instrumental in assisting DISCOMs by providing renewable energy for EV charging, offering a sustainable solution to the increasing electricity demand.

BENEFIT TO THE NATION

India, with a population of 1.428 billion and a rapidly growing major economy, ranks as the world's third-largest energy consumer *[13]*. and also as the world's third-largest carbon emitter, despite having relatively low per capita CO2 emissions *[14]*. Notably, the carbon intensity of its power sector exceeds the global average. In 2019, the country witnessed over 2.3 million premature deaths attributed to ambient and household air pollution *[15]*.

According to the World Energy Outlook 2021 by IEA, India's current share in global primary energy consumption stands at 6.1%. It is projected to rise to approximately 9.8% by 2050 under the stated policies scenario *[16][17]*.

India continues to grapple with an ongoing energy crisis, with some regions still lacking access to sufficient electricity and experiencing frequent load shedding, leading to power outages lasting 5-6 hours or more *[18]*.

Solar energy presents a definitive solution to address the ever-growing demand for electricity in the country. By leveraging the abundant solar resources and the demand-driven manufacturing of solar power components within our nation, enhances our national security by creating a decentralized grid without any single point of failure but also reduces the dependency and need for international energy imports which can be disrupted intentional/natural causes *[19]*.

As India strives to increase the proportion of renewable energy in its energy mix, significant focus is placed on Solar Farm projects. However, there are concerns about their negative impact, as these projects often consume and obstruct vast areas of fertile Farm Lands that could otherwise be used for agriculture. This not only degrades the quality of the soil but also necessitates the clearing of forests for additional farm land. Moreover, similar to Coal Plants, Solar Farms incur considerable transmission losses when transporting energy from these remote locations to urban centres. *[20][21]*

Unlike agricultural land that requires acquisition or long-term leasing, which increases the overall energy production costs, the rooftops of buildings in cities are typically unutilized areas, either empty or occupied by equipment for building services. However, these spaces present vast potential for power generation using Rooftop Solar PV Systems, which can be consumed locally within the city. A quick satellite image search of a city clearly reveals the untapped capacity of these barren and non-functional roofs. By utilizing these spaces, we can reduce the need to convert fertile farmland into Solar PV Systems, lessening our dependency on such valuable land for solar energy generation.

CONCLUSION

The advantages outlined above underscore the transformative potential of integrating solar energy into multi-unit residential and even commercial buildings. Passive cooling by use of solar installations helps by preventing excessive heat gain that not only enhances occupants' comfort but also effectively reduces the energy demand for cooling, leading to a substantial decrease in power consumption, lower energy bills, and decreased carbon emissions.

The extension of the waterproofing life is a vital consideration in residential buildings. The Solar PV System act as a protective shield against the elements, shielding the waterproofing layer from direct exposure to rain and massive heat gain. As a result, this prolongs the life of the waterproofing layer, minimizing the need for frequent maintenance and preventing water leakage issues. This, in turn, leads to substantial cost savings for residents, while also contributing to the overall sustainability of the building.

Usable Rooftop Space allows for recreational opportunities. Credit: [22]

Furthermore, the transformation of underutilized rooftop spaces into functional areas represents a paradigm shift. By capitalizing on these spaces, residents can enjoy recreational and productive environments, enhancing their quality of life. The creation of such usable spaces not only improves residents' well-being but also adds value to the property.

From an environmental perspective, the advantages extend beyond individual buildings. By generating solar power on residential rooftops, excess energy can be channeled into the grid, reducing transmission losses and supporting the grid's overall stability. This grid support is invaluable during peak load periods, offering relief to power distribution networks and mitigating the need for additional fossil fuel-based power generation.

At a larger scale, the cumulative reduction in carbon and toxic emissions is a crucial contribution to environmental conservation. By harnessing solar energy, the transition away from fossil fuels gains momentum, aligning with global efforts to combat climate change.

Moreover, reducing dependence on fossil fuels enhances energy security, reducing the nation's vulnerability to volatile energy markets.

An often-overlooked benefit lies in the preservation of fertile farmland. The utilization of rooftop spaces for solar installations negates the need to convert valuable agricultural land into solar farms. This approach not only safeguards essential farmland, and farmers in the long term but also minimizes the ecological impact of large-scale solar installations.

In this landscape of benefits, the pivotal role of the Solar Power Distribution Unit (SPDU) emerges as a transformative catalyst. The SPDU seamlessly integrates solar power into residents' daily energy mix, unleashing the full potential of rooftop spaces for energy production. This economical proposition propels solar adoption into a practical reality, empowering residents and ushering in energy sustainability. Importantly, the SPDU's impact is three-tiered: from societies to DISCOMs, and reaching the national level, aligning with global sustainability efforts. As a result, the SPDU stands as a beacon, driving progress in economic feasibility, environmental conservation, and a greener future.

REFERENCES

[1] Suehrcke, Harry, Eric L. Peterson, and Neville Selby. 'Effect of Roof Solar Reflectance on the Building Heat Gain in a Hot Climate', 1 January 2008. Suehrcke, Peterson, and Selby, 'Effect of Roof Solar Reflectance on the Building Heat Gain in a Hot Climate', 1 January 2008..

[2] Kamal, Mohammad Arif. 'An Overview of Passive Cooling Techniques in Buildings: Design Concepts and Architectural Interventions'. Civil Engineering 55, no. 1 (2012).

[3]Hui, Sam C M, and S Chan. Integration of Green Roof and Solar Photovoltaic Systems, 2011.

[4] Alvarado, Jorge L., Wilson Terrell, and Michael D. Johnson. 'Passive Cooling Systems for Cement-Based Roofs'. Building and Environment 44, no. 9 (1 September 2009): 1869–75. Alvarado, Terrell, and Johnson, 'Passive Cooling Systems for Cement-Based Roofs'..

[5] Cascone, Stefano. 'The Energy-Efficient Design of Sustainable Green Roofs in Mediterranean Climate: An Experimental Study'. Energy and Buildings 273 (15 October 2022): 112427. Cascone, 'The Energy-Efficient Design of Sustainable Green Roofs in Mediterranean Climate'..

[6] Azegami, Yasuhiko, Mineko Imanishi, Kunihiko Fujiwara, and Hiroyuki Kusaka. 'Effects of Solar Radiation in the Streets on Pedestrian Route Choice in a City during the Summer Season'. Building and Environment 235 (1 May 2023): 110250. https://doi.org/10.1016/j.buildenv.2023.110250.

[7] Prayas Energy. "Electricity Load Patterns," August 7, 2019. https://energy.prayaspune.org/our-work/article-and-blog/electricity-load-patterns.

[8] Gaur, Kajal, Harish Kumar, Rathour P. K. Agarwal, K. V. S. Baba, and S. K. Soonee. "Analysing the Electricity Demand Pattern." In 2016 National Power Systems Conference (NPSC), 1–6. Bhubaneswar, India: IEEE, 2016. https://doi.org/10.1109/NPSC.2016.7858969.

[9] Krieger, Elena M., Joan A. Casey, and Seth B. C. Shonkoff. 'A Framework for Siting and Dispatch of Emerging Energy Resources to Realize Environmental and Health Benefits: Case Study on Peaker Power Plant Displacement'. Energy Policy 96 (1 September 2016): 302–13. https://doi.org/10.1016/j.enpol.2016.05.049.

[10] Pillai, Gobind G., Ghanim A. Putrus, Tatiani Georgitsioti, and Nicola M. Pearsall. 'Near-Term Economic Benefits from Grid-Connected Residential PV (Photovoltaic) Systems'. Energy 68 (15 April 2014): 832–43. https://doi.org/10.1016/j.energy.2014.02.085.

[11] Held, Lukas, Alexandra Märtz, Dominik Krohn, Jonas Wirth, Martin Zimmerlin, Michael R. Suriyah, Thomas Leibfried, Patrick Jochem, and Wolf Fichtner. 'The Influence of Electric Vehicle Charging on Low Voltage Grids with Characteristics Typical for Germany'. World Electric Vehicle Journal 10, no. 4 (December 2019): 88. https://doi.org/10.3390/wevj10040088.

[12] Nunes, Pedro, Tiago Farias, and Miguel C. Brito. 'Day Charging Electric Vehicles with Excess Solar Electricity for a Sustainable Energy System'. Energy 80 (1 February 2015): 263–74. https://doi.org/10.1016/j.energy.2014.11.069.

[13] 'India Has Been Ranked Third Largest Primary Energy Consumer in the World'. Accessed 9 August 2023. https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1809204.

[14] 'Decarbonising India: Charting a Pathway for Sustainable Growth | McKinsey'. Accessed 10 August 2023. https://www.mckinsey.com/capabilities/sustainability/our-insights/decarbonising-india-charting-a-pathway-for-sustainable-growth.

[15] Pandey, Anamika, Michael Brauer, Maureen L. Cropper, Kalpana Balakrishnan, Prashant Mathur, Sagnik Dey, Burak Turkgulu, et al. 'Health and Economic Impact of Air Pollution in the States of India: The Global Burden of Disease Study 2019'. The Lancet Planetary Health 5, no. 1 (1 January 2021): e25–38. https://doi.org/10.1016/S2542-5196(20)30298-9.

[16] 'India Has Been Ranked Third Largest Primary Energy Consumer in the World'. Accessed 9 August 2023. https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1809204.

[17]'World Energy Outlook 2021 – Analysis - IEA'. Accessed 10 August 2023. https://www.iea.org/reports/world-energy-outlook-2021.

[18] 'Explained: Why India Is Facing Longest Power Cuts in 6 Years | India News - Times of India'. Accessed 10 August 2023. https://timesofindia.indiatimes.com/india/explained-why-india-is-facing-longest-power-cuts-in-6-years/articleshow/91198487.cms.

[19] 'India Has the Potential to Grow into a Global Supplier of Renewable Energy Equipment: Shri Piyush Goyal'. Accessed 10 August 2023. https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1868587.

[20] Turney, Damon, and Vasilis Fthenakis. 'Environmental Impacts from the Installation and Operation of Large-Scale Solar Power Plants'. Renewable and Sustainable Energy Reviews 15, no. 6 (1 August 2011): 3261–70. https://doi.org/10.1016/j.rser.2011.04.023.

[21] Ven, Dirk-Jan van de, Iñigo Capellan-Peréz, Iñaki Arto, Ignacio Cazcarro, Carlos de Castro, Pralit Patel, and Mikel Gonzalez-Eguino. 'The Potential Land Requirements and Related Land Use Change Emissions of Solar Energy'. Scientific Reports 11, no. 1 (3 February 2021): 2907. https://doi.org/10.1038/s41598-021-82042-5.

[22] Pinterest. 'Pin by C Johnson on Exterior Design | Solar Panels Architecture, House Roof Design, Terrace Design'. Accessed 10 August 2023. https://in.pinterest.com/pin/352125264587816799/.