igMin Research STEM ISSN: 2995-8067 A Multidisciplinary Open Access Journal

ENGINEERING SUBJECT
Energy Engineering | Power Engineering | Applied Engineering TOPIC(S)

Article Information

**Submitted:** February 27, 2024
**Approved:** April 04, 2024
**Published:** April 05, 2024

**How to cite this article:** Jayathunga D. Massive Solar PV Potential in Sri Lanka. IgMin Res. April 05, 2024; 2(4): 185-188. IgMin ID: igmin164; DOI: 10.61927/igmin164; Available at: igmin.link/p164

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**Keywords:** Solar photovoltaic; Electricity generation; GHG emission; CDM

Short Communication

# Massive Solar PV Potential in Sri Lanka

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## Abstract

Sri Lanka is facing an energy crisis due to insufficient exploitation of renewable energy resources and high reliance on imported fossil fuels. Building-integrated PV (BIPV) systems are one approach that provides various benefits in countries with limited land areas and congested metropolitan regions for ensuring energy security. This study was conducted to evaluate the rooftop solar PV capacity and yearly electricity generation potential in selected provinces in Sri Lanka. The study found 115 km2 of rooftop area for solar PV installation in four Sri Lankan provinces; Sabaragamuwa, Western, Northern, and North Central with approximately 25 GW of solar PV installation capacity could lead to annual electricity generation of 45 TWh which could reduce carbon emissions by 20 million $tCO_2$ per year.

Today, climate change and environmental pollution have become serious challenges for mankind. Energy use for human activities has been identified as a major cause of climate change and other environmental problems. GHGs and other emissions from fossil fuel-based energy use contribute to global warming, water and air pollution, health impacts, and various other negative impacts. In addition, fossil fuels can face supply constraints and fluctuating prices, especially with changing global dynamics. All of the above factors have made it evident that it is necessary to shift to indigenous renewable energy resources.

Sri Lanka is currently facing a severe energy crisis, which partially stems from the insufficient exploitation of indigenous renewable energy resources, leading to continued high reliance on imported fossil fuels. Even though Sri Lanka is endowed with a variety of renewable energy resources, there is a lack of energy security, and the country is failing to provide an uninterrupted energy supply at affordable prices to the populace. Energy poverty is sharply increasing, while industrial activities are painfully disrupted. Moreover, according to data published by the World Bank Group, $CO_2$ emissions per capita are increasing in the country [1]. Thus, as a country, Sri Lanka needs to find the best pathways to make a sustainable energy transition, preferably with the use of local resources and technologies.

At present, as major hydro resource potential has been almost fully exploited, solar energy is the next best option available for the country. Solar PV technology has shown a dramatic reduction in the levelized cost of energy (LCOE) over the last few decades [2]. As a result, the global solar PV installed capacity is rapidly increasing, with China leading the way, followed by the United States, Japan, India, Germany, Australia, the Republic of Korea, and Spain in descending order of total installed capacity [3]. Table 1 reports the installed PV capacity as a ratio of the total ground area available in each of the aforementioned countries.

Building Building-integrated PV (BIPV) installations can provide numerous benefits for countries with limited land area and congested urban spaces. This approach has the advantage of using existing rooftops and facades, which saves space that would otherwise be wasted and reduces costs and resource requirements. Consequently, various models and programs have been developed to promote rooftop solar (RTS) power generation by incentivizing citizens. To name a few models, the OPEX (PPA) model, the CAPEX model, the CAPEX+ OPEX model, and the RESCO model [4,5]. RTS-promoting programs include the provision of solar panels at a reduced cost with World Bank Group support in India, the Low-Income Home Energy Assistance Program (LIHEAP) and Community solar programs in the United States [6], the Building Integrated Photovoltaic (BIPV) program in Korea [7], and SEAT Al Sol in Spain [8]. Most of these programs are primarily concerned with the provision of incentives, low taxes, subsidies, and support schemes, or a combination of a few of these.

**Table 1:** Details of the leading countries in the solar PV market..

| Country | PV capacity (GW) | Solar PV installed capacity as a ratio to the total ground area in the country (GW/million km²) |
|---|---|---|
| China | 307.1 | 32.00 |
| USA | 122.1 | 12.42 |
| Japan | 77.8 | 205.82 |
| India | 60.2 | 18.31 |
| Germany | 59.2 | 165.83 |
| Australia | 23.4 | 3.04 |
| Republic of Korea | 19.5 | 195.00 |
| Spain | 14.8 | 29.25 |

Identifying solar power generation potential is critical for developing RTS strategies. Geographic location, time of day, season, weather, and landscape are all factors that influence solar radiation [9]. Sri Lanka receives 1247-2106 kWh/m² of global horizontal irradiance (GHI) [10], resulting in massive solar PV potential. With approximately 434 MW of installed solar capacity [11], solar currently accounts for 4.37% of electricity generation in Sri Lanka [12]. Therefore, it is worthwhile to investigate the total rooftop installation capacity in each province because the available rooftop area is not sufficiently utilized at the moment. Accordingly, this study determined the solar PV capacity and yearly electricity generation using JINKO - 550Wp [13], SLSEA-recognized solar panels, and 0.2 plant factor [14]. The three calculation methods presented and applied in the estimation of rooftop area value for each province are the constant value method, the manual method, and the Arc GIS-based method. The constant value method findings are validated using the manual method and the Arc GIS-based method. All techniques rely on significant correction factors to account for shade, tilt, rooftop facing, structural feasibility of rooftops, PV system performance loss owing to panel spacing, and other minor issues.

The constant value method utilized building census data published by the Department of Census and Statistics with interpolation for the recent year 2020 to increase the accuracy of the results while accounting for the population growth rate. A survey was done on the Google Earth platform to assess the average building size. As a result, the constant value technique employed equation 1 to estimate the total rooftop area in each province, whereas equation 2 was used to determine the effective area that might be used for solar PV installation. In the manual method, individual rooftop identification and area measurement were performed for selected sample areas, and the rooftop area of a sample was then interpolated for areas with similar building density using Google Earth Pro and Google Maps to calculate the total rooftop area available for solar installation, as shown in equation 3. The Arc GIS-based method uses the same equation but with a different way of sample definition and area extraction. The chosen province was then divided into three sections based on building density, and high-resolution photos of sample regions were acquired from each division and identified using Arc Map to automatically identify rooftops.

$$A_T = N \times U \quad (1)$$

$$A_E = A_T \times C_1 \times C_2 \times C_3 \times C_4 \quad (2)$$

$$A_E = \left(\sum_{i=1}^{i=n} \frac{A_M}{A_G}\right) \times A_I \times C_1 \times C_2 \times C_3 \times C_4 \quad (3)$$

Where;

$A_T$: Total rooftop area in the province

N: Total Building Units

U: Average building size

$A_E$: Effective area for solar PV installation

$C_1$, $C_2$, $C_3$, $C_4$: Correction factors for shading, structural feasibility, rooftop facing, and performance loss due to panel spacing and other potential issues

$A_M$: Measured rooftop area of the sample

$A_G$: The ground area of the sample

$A_I$: Interpolation area

n: Number of samples considered

The current analysis undertaken by us predicted 22.50 km², 10.77 km², 14.95 km², and 68.83 km² of rooftop area available that can be used to install solar PV, as graphically illustrated in Figure 1. As a consequence, the total rooftop area available in all four provinces considered is approximately 115 km², with the Western province having the highest rooftop availability for solar PV installation. After determining the above areas, the potential solar PV installation capacities were identified and validated for the selected provinces [15].

Accordingly, 4.88 GW, 2.34 GW, 3.24 GW, and 14.92 GW of solar PV installation capacity in Sabaragamuwa, Western, Northern, and North Central provinces respectively, respectively, resulted in 8.55 TWh, 4.09 TWh, 5.86 TWh, and 26.15 TWh of annual electricity generation potential, as shown in Figures 2,3.

Furthermore, it was determined that if this rooftop potential is used to deploy solar PV, it can lead to a carbon emissions reduction amounting to 20,401,200.15 $tCO_2$ (e) per year in total for the selected provinces. Our analysis results further indicate that by implementing a carbon-carbon-crediting Clean Development Mechanism (CDM), Sri Lanka has the potential to earn US$ 78 million annually. Therefore, this is a type of energy project Sri Lanka should be looking forward to, particularly in the energy and economic crisis of this present situation.

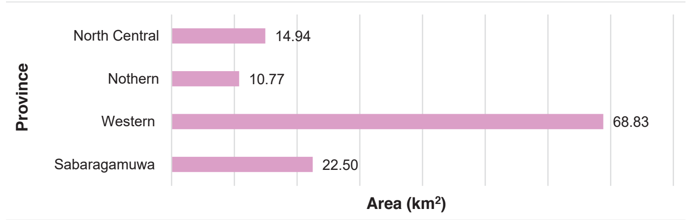


**Figure 1:** Total available rooftop areas in selected provinces that can be used for rooftop solar PV installation.

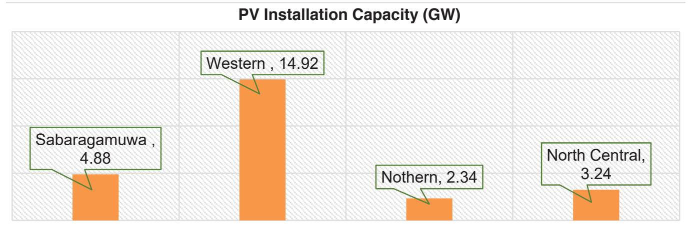


**Figure 2:** PV installation capacity in Sabaragamuwa, northern, north-central, and western provinces.

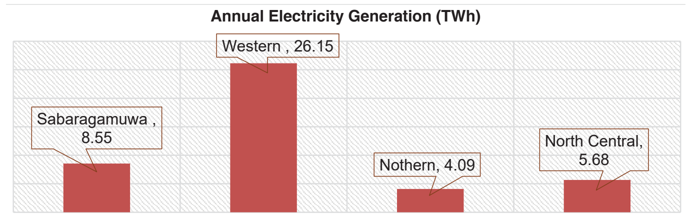


**Figure 3:** Annual electricity generation in Sabaragamuwa, northern, north-central, and western provinces.

## Conclusion

Climate change and environmental pollution are serious challenges for mankind. Sri Lanka is facing a severe energy crisis due to insufficient exploitation of indigenous renewable energy resources. Solar energy is the next best option available for the country, and the global solar PV installed capacity is rapidly increasing. Building-integrated PV (BIPV) installations can provide numerous benefits for countries with limited land area and congested urban spaces. The three calculation methods presented and applied in the estimation of rooftop area value for each province are the constant value method, manual method, and Arc GIS-based method. The study found 115 km² of rooftop area for solar PV installation in four provinces, where 22.50 km², 10.77 km², 14.95 km², and 68.83 km² of rooftop area in the Sabaragamuwa, Western, Northern, and North Central provinces have 4.88 GW, 2.34 GW, 3.24 GW, and 14.92 GW of solar PV installation capacity could lead to annual electricity generation of 8.55 TWh, 4.09 TWh, 5.86 TWh, and 26.15 TWh for each province respectively, reducing carbon emissions around 20 million $tCO_2$ per year.

## References

1. World Bank Group. CO2 emissions (metric tons per capita) | Data. World Bank Group. 2024. https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?end=2019&start=1990&view=chart
2. Statista. CSP installation cost worldwide 2021. Statista. 2024. https://www.statista.com/statistics/809796/global-solar-power-installation-cost-per-kilowatt/
3. Existing capacity of solar PV worldwide by select country 2021. Statista. https://www.statista.com/statistics/264629/existing-solar-pv-capacity-worldwide/
4. Singh D, Sinha J, Shrimali G. The Residential Rooftop Solar Accelerator. 2018. https://www.climatepolicyinitiative.org/wp-content/uploads/2020/07/The-Residential-Rooftop-Solar-Accelerator_Instrument-Analysis.pdf
5. "Understanding the Two Solar Business Models: CAPEX & RESCO." Galaxy Solar. 2024. https://galaxysolarenergy.com/understanding-the-two-solar-business-models-capex-resco/
6. US Department of Energy. Biden-Harris Administration Launches New Solar Initiatives to Lower Electricity Bills and Create Clean Energy Jobs. US Department of Energy. 2024. https://www.energy.gov/articles/biden-harris-administration-launches-new-solar-initiatives-lower-electricity-bills-and
7. How to encourage residents and businesses to install building-scale clean energy. 40 knowledge. https://www.c40knowledgehub.org/s/article/How-to-encourage-residents-and-businesses-to-install-building-scale-clean-energy?language=en_US
8. Verdict Media Limited. SEAT Al Sol - Rooftop Solar Project, Spain. Power Technology. https://www.power-technology.com/marketdata/seat-al-sol-rooftop-solar-project-spain/
9. US Department of Energy. Solar Radiation Basics. Office of Energy Efficiency and Renewable Energy. 2024. https://www.energy.gov/eere/solar/solar-radiation-basics
10. Solar Energy | Sri Lanka Sustainable Energy Authority. Sri Lanka Sustainable Energy Authority. 2024. http://www.energy.gov.lk/index.php/en/renewable-energy/technologies/solar-energy
11. Sri Lanka launches tender for 100 MW solar park. PV magazine. 2022. https://www.pv-magazine.com/2022/08/29/sri-lanka-launches-tender-for-100-mw-solar-park/
12. Global Data Change Lab. Share of Electricity Production by Source, Sri Lanka. Our World in Data. 2024. https://ourworldindata.org/grapher/share-elec-by-source?country=~LKA
13. L Jinko Solar Co. Estimating the capacity of rooftop solar in selected provinces in Sri Lanka. 2020. www.jinkosolar.com

ISSN 2995-8067 DOI: 10.61927/igmin164

14. Ratnasiri J. Renewable energy share in power generation. President's Media Division. 2024. https://srilankatwo.wordpress.com/2020/09/26/renewable-energy-share-in-power-generation-president-misled-by-advisers/

15. Jayathunga D, Wickramarathna T, Karunathilake H, Witharana S. Rooftop Solar Photovoltaic-based Clean Development Mechanism for Sri Lanka. SLEMA J. 2022; 25: 12–21. doi: http://doi.org/10.4038/slemaj.v25i1.35.

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