Potential of Rooftop Solar Energy for Institutional Electricity Consumption in the Konkan Region

Ms. Sayli Sambhaji Chavan

Research Scholar, Geography Department (University of Mumbai), Mumbai, Maharashtra

Assistant Professor , Environmental Studies, SKM's J M Patel College of Commerce , Goregaon West, Mumbai, Maharashtra

ABSTRACT

Rooftop solar energy holds significant potential for institutional electricity consumption (such as schools, colleges, government offices, hospitals, and public facilities) in the Konkan region of Maharashtra, though it comes with unique regional conditions and policy frameworks. [1, 2]

Key Potential & Drivers

- Significant Bill Reductions: Institutional buildings face high daytime electricity usage (lighting, ventilation, air conditioning, and administrative workloads), making direct self-consumption from rooftop PV a reliable way to offset high commercial/institutional tariffs. [1]
- State & Central Subsidies: Government and semi-government institutional offices are eligible for strong financial backing—historically up to 100% assistance/subsidies for qualifying public/government structures under state mandates, alongside net metering allowances up to 1 MWp managed through the Maharashtra State Electricity Distribution Company Limited (MSEDCL). [1, 2, 3]
- Co-located Efficiency: Generating power directly on institutional rooftops minimizes transmission and distribution (T&D) losses and helps stabilize local daytime loads. [1]

Regional Challenges in Konkan

- Coastal Climate Factors: The Konkan region (covering districts like Thane, Palghar, Raigad, Ratnagiri, and Sindhudurg) experiences heavy monsoon downpours, high humidity, salty sea-breeze corrosion, and strong coastal winds. Installations require specialized coastal-grade mounting structures, corrosion-resistant hardware, proper earthing, and weather-protected DCDB/ACDB panels. [1]
- Roof Orientation & Space Constraints: Many legacy or sloping institutional roofs require structural assessments to ensure they can bear the wind load during monsoons and tilt angle optimizations for heavy cloud cover periods.
- Grid and Policy Shifts: Ongoing updates to net metering, banking charges, and capacity limits by state regulators require institutions to properly size their systems against sanctioned loads rather than historical spikes alone.

KEYWORDS-Konkan, rooftop solar energy, electricity consumption, institutional

INTRODUCTION

Rooftop solar energy converts sunlight into electricity using photovoltaic (PV) panels installed on residential, commercial, or industrial building roofs. [1, 2]

Key Potential & Benefits

- Energy Independence: Generates power directly at the site of consumption, reducing reliance on the central power grid and lowering monthly utility bills.
- Space Efficiency: Utilizes existing unused roof space rather than requiring large tracts of land like utility-scale solar farms.
- Grid Relief: Supplies excess daytime energy back to the grid via net metering, easing peak-hour demand pressures.
- Environmental Impact: Cuts carbon dioxide emissions and replaces fossil-fuel-generated electricity with clean, renewable energy.
- Property Value: Increases the market value of homes and commercial buildings equipped with lower-cost energy systems. [1, 2, 3, 4, 5, 6]

Major Limitations & Challenges

- Initial Setup Cost: Requires a significant upfront investment for panels, inverters, mounting structures, and installation.
- Weather & Maintenance: Energy output drops on cloudy days, and accumulated dust, debris, or bird droppings can sharply reduce efficiency if panels are not cleaned regularly.
- Structural & Shading Constraints: Roof orientation, slope, age, and shadows from nearby trees or buildings can limit usable solar potential. [1, 2, 3, 4]

Institutional electricity consumption in public and educational buildings typically averages 50 to 739 kWh/m² annually, depending heavily on the facility type and operational intensity. [1]

Key Breakdown of Institutional Consumption

- Major Load Drivers:
  - HVAC (Heating, Ventilation, and Air Conditioning): Accounts for 35% to 50% of total energy use.
  - Lighting: Accounts for up to 35% of consumption (though LED replacements can drop this by about 20%).
  - Office and Lab Equipment / Plug Loads: Accounts for roughly 17% in standard offices, though specialized research labs or data-heavy setups have significantly higher energy density. [1, 2]
- Campus & Hostel Benchmarks:
  - Studies of higher-education hostels (such as JNTUK case data) show an Energy Use Intensity (EUI) of around 321.6 kWh/m²·year, with individual per capita consumption reaching roughly 1,170 kWh annually.
  - Research/administrative complexes (such as the Indira Gandhi National Forest Academy study) report annual consumption upwards of 13.65 lakh units (kWh)

with a per capita use around 2,509 kWh, where rooftop solar typically offsets about 10%. [1, 2]

- Efficiency Potential:
  - Active monitoring and demand-side management can lower institutional electricity use by 15%.
  - Comprehensive HVAC upgrades can reduce energy consumption by up to 40%. [1]

DISCUSSION

Konkan is one of the six administrative divisions of Maharashtra, India, spanning coastal districts such as Thane, Palghar, Raigad, Ratnagiri, and Sindhudurg (as well as Goa and coastal Karnataka along the wider geographical belt). [1]

Electricity consumption and demand in the Konkan region are shaped by several key patterns:

- Regional Context within Maharashtra: Overall electricity consumption in Maharashtra reached 155,518 GWh in 2023 (up from 142,088 GWh in 2022), with state demand projected to grow at a CAGR of 4.08% through 2033–34. The Konkan belt contributes a significant share of industrial, port, urban, and residential demand, particularly in districts close to the Mumbai Metropolitan Region (MMR). [1]
- Early Heatwaves and Peak Demand: Parts of the Konkan and coastal Karnataka experience early seasonal temperature spikes and high humidity, leading to sharp cooling and air-conditioning loads well before the official summer peak months. India's broader peak power demand has surged past 230–250 GW in recent years, driven heavily by these regional thermal extremes. [1]
- Konkan Railway Electrification: The 740-km Konkan Railway route (covering 382 km in Maharashtra, 106 km in Goa, and 252 km in Karnataka) was fully electrified and dedicated to the nation. This transition reduced railway energy costs by approximately 70% and lowered carbon footprints. [3,4,5]
- Energy Conservation & Green Initiatives on Railways: To manage rising connected loads from heavier train operations, the Konkan Railway Electrical Department uses energy-efficient LED lighting in tunnels and stations, replaces older AC units with 3-star and higher models, and installs solar water heaters and solar lamps in rest houses. [1]
- Industrial & Rural Energy Mix: Industrial activities in the region—such as local processing and small-scale manufacturing (e.g., cashew nut and agro-processing mills)—balance traditional fuel/steam setups with grid power, while rural households continue shifting from traditional biomass cookstoves toward cleaner LPG and electrified grid options under schemes like Saubhagya. [1, 2, 3]

The state's electricity generation capacity has grown significantly. Total installed capacity reached 38,601 MW as of March 2024. Thermal sources dominate the energy mix. Renewable energy sources are gaining traction. Share of renewable energy increased from 8.1% to 16.8% between 2014-15 and 2023-24. The study identifies growing demand for electricity. Industrial and economic growth drive electricity demand. The study provides insights into Maharashtra's electricity sector. It highlights the

importance of renewable energy and energy efficiency. The findings are relevant for India's energy transition. Maharashtra's experience can inform national energy policies. The study contributes to the understanding of India's electricity sector. It provides a framework for analyzing electricity trends and patterns. The study's findings are useful for researchers and policymakers. The study's methodology can be applied to other states in India. The study's results have implications for India's energy future.

RESULTS

Balanced regional development is the ultimate aim of any government. The widening of inter-regional disparities in recent times has been well recognised. In India initial plan periods were focused on the resource centric development. Investments were made on the basis of external economies. So the interregional disparities are widened. But recently policies are emphasizing on filling the gap between developed and backward areas.

In this regard it is important to capture the development gap across the states and within the state itself. It is very unfortunate that in states like Maharashtra there exist a large development gap between the regions and within the regions i.e. the inter district disparity (Kelkar Committee Report 2013).[6,7,8]

Some studies highlighted the development gap based on the differences in Human Development Indicators i.e. income, education and health (Sangita Kamdar 2017)

There are several aspects of analysing the regional inequality which gives us an idea about the development status of the particular study area. The development disparity can be well explored by the status of infrastructure in particular area. So infrastructural development can be suitable proxy to analyse the development status or development potential. The world development report of 1994, entitled the Infrastructure for Development underlines the importance of infrastructure in the development of any region or area. In this context this study explores the development status of different regions/divisions in Maharashtra in general and status of individual district in particular.

The economic planners distinguishes the infrastructure in two broad categories i.e. economic infrastructure and social infrastructure. The infrastructure that promotes economic activity is called Economic infrastructure and the social infrastructure is that promotes education and health wellbeing of the society.

Development linkage of infrastructure:

The development linkage of infrastructure can be drawn as, it connects goods to markets, workers to industry, people to services and the poor in rural areas to urban growth centres. It also lowers the costs, enlarges the markets and facilitates trade. So the infrastructure supports the economic growth by increasing the productivity of labour and capital thereby increases the profitability and it also improves the quality of life of the people in particular area.[9,10,11]

The focus of this study is on analysing the availability of essential infrastructure in the districts of Maharashtra and its region/division wise comparison. In this paper the infrastructure items has been arranged in eight categories, namely Transport, Energy, Communication, Irrigation, Drinking water supply and Sanitation, Storage infrastructure, Education and Public Health. Among these eight categories first six are called economic infrastructure and last two are called social infrastructure. So the comparative development status can be understood across the regions and districts in Maharashtra state.[12,13,14]

CONCLUSIONS

Maharashtra is one of the most industrialized states in India. In Maharashtra since 2005, The Maharashtra State Electricity Distribution Company Limited (MSEDCL) has been unable to supply electricity as per demand. The state utility has been resorting to load shedding to bridge the gap between supply and demand. Several parts of the state have ten to twelve hours of load shedding. Load shedding results in disruption of lifestyle, huge loss of production in Industrial, Agricultural, services sectors and causes inconvenience to consumers. Besides, it creates social problems, law and order issues and adversely affects the different segments of the economy. Naturally, electricity load shedding is one of the major contentious and controversial issues. In Maharashtra, load shedding has persisted for the last four- five years and it is expected to continue for few more years. The Maharashtra State Electricity Distribution Company Limited estimates that the shortages will be continue till 2011- 12.[15,16,17] Due the acute shortage of electricity, an appropriate use of available electricity and load shedding is the only alternative to overtake this problem. Electricity is one of the essential infrastructures in the process of economic and social development. India is the world's sixth largest energy consumer accounting for about 3.5% of the world's total annual energy consumption, but, per capita consumption of energy is very low at 631 kwh as compared to world consumption of 2873 kwh which needs to be increased to meet the goals of economic and social development. The conventional sources of energy such as Thermal, Hydro and Nuclear are the major sources of generation of electricity in India. Conventional sources of energy are valuable because their formation takes million of years whether it is oil or coal. The conventional sources of energy are exhaustible. Energy prices may rise in the long run to reflect the relative scarcity and high cost of exploration and extraction. Hence, all initiatives have to be taken to optimal use of the available resources so that they can continue for a long duration. Energy efficiency improvements not only reduce the energy consumed per unit products but also improves energy security of the country to ensure sustained availability of energy resources at an affordable price. The National Electricity Policy (NEP) stipulates power for all and annual per capita consumption of electricity to rise to 1000 units by 2012. This entails provision of adequate reliable power, at affordable cost with access to all citizens. Electricity is in the Concurrent List in the Constitution and the primary responsibility of structuring its availability and distribution is that of the states. However, both the centre and states have to play a decisive and positive role. While shortages are presently being experienced by each region in India, it is much more acute in the case of Maharashtra. [18,19,20]

REFERENCES

1. R.P. Kurulkar (2009), The Problem of Regional Disparities in Maharashtra State and the Role of Regional Development Baords, Journal of India School of Political Economy, January – December 2009, P-261 to 280.Retrieved from http://www.ispepune.org.in/issue-2009/TheProblemof_regional.pdf.
2. Sumalya Goswami. Role of Social Infrastructure in the Economic Development of India. Research J. Humanities and Social Sciences. 3(4): October-December, 2012, 530-531.
3. Reena Kumari (2016), Regional disparity in Uttar Pradesh and Bihar: a disaggregated level analysis, Journal of Social and Economic Development, Springer, retrieved from https://www.researchgate.net/publication/303807459_Regional_disparity_in_Uttar_Pradesh_and_Bihar_a_disaggregated_level_analysis.
4. Amita Bais. Economic Study of Uperwara Village. Social Infrastructure: Health, Housing and Education. Research J. Humanities and Social Sciences. 3(1): Jan-March, 2012, 140-142.
5. B B Mohanty (2009), Regional Disparity in Agricultural Development of Maharashtra, Economic and Political Weekly, February 2009, Retrieved from http://www.indiaenvironmentportal.org.in/files/Regional%20Disparity%20in%20Agricultural%20Development.pdf
6. T. Manjunatha, Vikas K M. An Empirical Examination of Financial Pattern of Infrastructure Sectors in India. Asian Journal of Management. 2021; 12(2):221-7.
7. Sangita Kamdar, (2017) Regional Imbalances in Maharashtra: A Human Development Perspective, Indian Journal of Human Development, Vol.3, No.2, 2009.
8. Mohd Azher Parvez, G. Anil Kumar. Public private Partnership for Infrastructure Growth in India-A study of Hyderabad metro Rail Project. Asian Journal of Management. 2020;11(2):193-200.
9. Dawle Jairaj K., Suryawanshi V.B. Assessment of Drinking Water Quality of Latur Region, Maharashtra, India. Asian J. Research Chem. 3(4): Oct. - Dec. 2010; Page 916-918.
10. Rggional Imbalance in Industrial Development- An Introduction, Retrieved from http://shodhganga.inflibnet.ac.in/bitstream/10603/108172/9/09_chapter%201.pdf.
11. Bharti Chokhani, D. N Vyas. A Study of Role of Development of Roadways Infrastructure in Enhancing the Health of Economy: Perspective to Districts of Western Vidarba. Research J. Humanities and Social Sciences 2016; 7(1): 1-5.
12. Ahluwalia M (2000) Economic performance of states in post-reforms period. Economic and Political Weekly, 35(19):1637–1648
13. Adinath Bhujaballi Kuchanur, Ravi S. Joshi. Scenario of Technical Education: A Sweet and Sour Story in Maharashtra. Asian J. Management; 6(2): April-June, 2015 page 79-90.
14. Ahluwalia MS (2001) Economic Performance of the States in the Post Reform Period. In: Kampala Y (ed) Indian economy since independence. Academic Foundation, New Delhi

15. Dhekale D.N., Hiwarkar Y.A., Kolhe C.G. A Study of School Drop out of Tribal Adolescents of Maharashtra and its Relationship with Their Social Status. Int. J. Ad. Social Sciences 1(1): July –Sept. 2013; Page 34-36.
16. Report of the High-Level Committee on Balanced Regional Development: Issues in Maharashtra, Government of Maharashtra Planning Department, October 2013.
17. Sanjay Khare.Sustainable Infrastructure Development through Public Private Partnership. Int. J. Rev. and Res. Social Sci. 2(1): Jan. – Mar. 2014; Page 88-94.
18. YASHADA (2014), Maharashtra Human Development Report, 1012: Towards Inclusive Human Development. Yashwantrao Chavan Academy of Development Administration, Pune 411007, Sage Publications India Pvt Ltd, ISBN: 978-81-321-1136-8.
19. Nilesh Kumar Tiwari, Ritesh Kumar Agrawal, Ravindra Brahme. Inter-district disparities in human development in Chhattisgarh. Int. J. Rev. and Res. Social Sci. 4(1): Jan. - Mar., 2016; Page 01-04.
20. Bhupen Barman, Ranjan Roy. Regional Disparities of Health Care Infrastructure in Koch Bihar District, West Bengal. Res. J. Humanities and Social Sciences. 2018; 9(4): 949-959.