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DAILY EDITORIAL ANALYSIS

TOPIC

DISCOVERING INDIA'S SOLAR GOLDMINE

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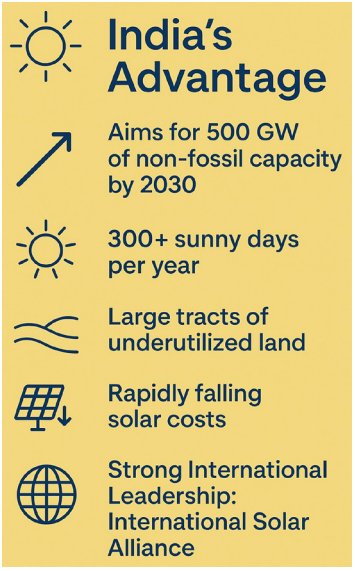
Context

- There is a need for data-driven reassessment of India's solar energy potential to unlock investment, drive innovation, and accelerate the transition to net-zero emissions by 2070.



About Solar Power in India

- India is rapidly emerging as a global leader in clean energy, with over 110 GW of installed solar capacity.
  - India's total renewable energy capacity reached **237.5 GW**.
- **India's Solar Potential:** According to **The Energy and Resources Institute (TERI),** India's total solar potential is estimated at 10,830 GW. It includes:
  - Ground-mounted solar on barren land: 4,909 GW;
  - Agri-PV (on plantations): 4,177 GW;
  - Rural and urban rooftop solar: 960 GW;
  - Rail, road, and building-integrated PV: 684 GW;
  - Floating solar PV: 100 GW;
- **Global Comparison:** According to the **World Bank's Global Solar Atlas:**
  - India ranks among the top countries with excellent solar PV conditions, with high irradiance and low seasonality.
  - Namibia, Chile, Australia, and parts of the Middle East and North Africa boast high solar PV potential, often exceeding 4.5 kWh/kWp daily.
  - China and the United States, while leading in installed capacity, have lower average solar irradiance compared to India.

Global Solar Atlas (GSA)

- It is a free, web-based tool developed by the **World Bank's Energy Sector Management Assistance Program (ESMAP)** in collaboration with Solargis.
- It provides high-resolution data and maps to assess solar energy potential across the globe, especially in developing countries.

Key Features

- **Interactive Mapping:** Zoom into any location worldwide with up to 1 km resolution.
- **Solar Resource Data:** Includes Global Horizontal Irradiance (GHI), Direct Normal Irradiance (DNI), and PV power potential.
- **PV Calculator:** Offers site-specific and regional assessments of photovoltaic energy generation.
- **Downloadable Maps:** Country-specific poster maps and GIS layers for planning and analysis.
- **Hourly Profiles:** Monthly summaries and 12×24 hourly averages for solar generation variability.

Challenges in Harnessing India's Solar Power Potential

- **Outdated Estimates**: India's official **solar potential estimate — 748 GWp** — was based on **2010 wasteland data and 2011 census** figures. It had limited strategic planning and investment in solar infrastructure.
  - Lack of granular, geospatial data on irradiance, land use, and infrastructure proximity.
  - Insufficient coordination between central and state agencies on siting and resource allocation.
- **Changing India's Land Use Pattern:** Urbanisation, industrialisation, Agricultural land diversion and digitalisation are changing India's land-use patterns.

  - Example: The **Pavagada and Bhadla solar parks** faced local opposition over land leasing and environmental concerns.
- **Grid Integration and Infrastructure Gaps:** Transmission bottlenecks limit the evacuation of solar power from generation sites to consumption centers.
  - Lack of smart grid systems hampers efficient load balancing and storage integration.
- **Weak Domestic Manufacturing Ecosystem:** India lacks backward integration in the solar value chain—no domestic production of wafers or polysilicon.
  - Heavy reliance on imports, especially from China, and limited R&D and innovation in high-efficiency modules and recycling technologies.
- **Low Adoption and Policy Barriers in Rooftop Solar:** Net metering restrictions, bureaucratic delays, and inconsistent state policies discourage adoption.
  - High upfront costs and limited access to concessional loans for small consumers.

Key Efforts and Initiatives

- **Production Linked Incentive (PLI) Scheme:** Launched to boost domestic manufacturing of high-efficiency solar PV modules.
- **Solar Park Scheme:** Aims to establish 50 solar parks with a cumulative capacity of ~38 GW by 2025–26.
  - These parks attract investment and enable economies of scale.
- **PM-KUSUM Scheme:** Targets 30.8 GW of solar capacity by 2026 through decentralized solar for agriculture.
  - Promotes indigenous manufacturing and rural energy access
- **PM Surya Ghar:** Provides up to 300 units of free electricity per month to 1 crore households via rooftop solar.
  - ₹75,021 crore outlay includes subsidies, incentives for DISCOMs, and capacity building.
  - Expected to add 20 GW of rooftop solar capacity.
- **International Solar Alliance (ISA):** India-led global initiative with 120+ member countries.
  - Promotes solar deployment in developing nations, especially Africa.
  - Programs include SolarX Startup Challenge, Green Hydrogen Innovation Centre, and Solar Data Portal.
- **Grid and Storage Integration: Green Energy Corridor** project enhances transmission infrastructure.
  - Smart grid and energy storage solutions are being scaled to support intermittent solar supply.
- **Policy and Regulatory Support:** 100% FDI permitted under automatic route.
  - Waiver of inter-state transmission charges for solar projects commissioned.
  - Green Open Access Rules and net-metering reforms promote decentralized solar.

Way Forward: Utilising Full Potential Of Solar Energy

- **Floating Solar PV (FSPV)** It offers a solution to **land scarcity** and water body utilisation.
  - Improved mapping of **inland water surfaces**, better understanding of **regional evaporation losses**, and localised performance data can unlock **~100 GW potential**.
- **Methodologies Reflecting Present-Day Realities:** Modern, data-rich, and granular assessments need to incorporate solar irradiance and land gradient; proximity to substations and roads; ISRO's remote sensing data; **Global Solar Atlas** & NREL radiation data and Transmission grid data from CEA.
- **Economic Implications of** Reassessing the Solar Potential**:** A robust demand pipeline will catalyse the **solar panel recycling industry**, especially for materials like silver, copper, and silicon.
  - **Attract larger domestic and foreign investments;**
  - Accelerate **solar manufacturing ecosystems;**
  - Encourage production of **cells, wafers, polysilicon, and metallurgical-grade silicon;**
  - Boost **ancillary industries** and generate **thousands of green jobs**

- **Enabling Smarter Land and Resource Planning**: It enhances India's **energy security** and supports its vision of becoming a **global solar hub**. State and central governments can:
  - Strategically allocate **land, water**, and **transmission corridors;**
  - Promote **shared infrastructure** for roads, power lines, and worker townships;
  - Achieve **economies of scale** and increase deployment efficiency.
- **Global Leadership and Strategic Vision:** India's leadership in the International Solar Alliance and initiatives like **'One Sun, One World, One Grid'** positions it to champion global solar transitions. A data-enabled approach will:
  - Set new benchmarks for solar potential assessment;
  - Drive equitable and sustainable energy access;
  - Strengthen India's role as a clean energy superpower

Source: ORF

Mains Practice Question

[Q] In what ways does the concept of 'India's Solar Goldmine' reflect the country's strategic potential in renewable energy, and how can it shape India's role in global climate leadership?