



Perspective: India's Green Energy Strides

For Prelims: [Asian Development Bank \(ADB\)](#), [Asia-Pacific Climate Report 2024](#) [Solar Energy](#), [Wind Power](#), [Renewable Energy](#), [COP26](#), [Green Hydrogen](#), [PM-KUSUM \(Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhayan\)](#), [National Green Hydrogen Mission](#), [Solar Park Scheme](#), [Land Acquisition](#), [PLI Scheme for High-Efficiency Solar PV Modules](#), [Green Energy Corridor](#), [Viability Gap Funding \(VGF\)](#), [International Solar Alliance \(ISA\)](#), [One Sun, One World, One Grid \(OSOWOG\)](#), [Solar Pv Cell Imports](#), [Solar PV Module](#), [Skill Development](#), [Solar Technology Application Resource Centre \(Star-C\)](#).

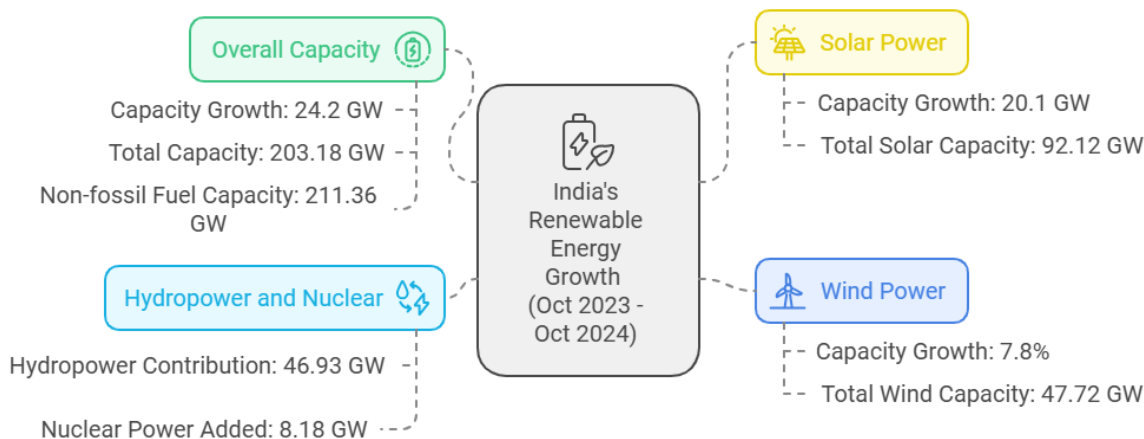
For Mains: Significance of Renewable Energy in Ensuring Energy Security, Sustainable Development and Reducing Environmental Pollution & Degradation.

Why in News?

Recently, the [Asian Development Bank \(ADB\)](#) in its [Asia-Pacific Climate Report](#), 2024 highlighted India's shift from unsustainable [fossil fuel](#) subsidies to investing in cleaner, greener energy solutions.

- The report highlighted India's "**remove, target, and shift**" strategy that reduced fossil fuel subsidies by **85%** from 2014 to 2023, freeing up funds for [renewable energy](#) investments.

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What are the Key Achievements of India's Renewable Energy Sector?

- **India's Fossil Fuel Subsidy Reforms:** India began reducing petrol and diesel subsidies gradually from 2010 to 2014, followed by incremental tax hikes up to 2017.
 - As per **Asia-Pacific Climate Report 2024**, by 2023, **fossil fuel subsidies** were reduced by **85%**(from USD 25 billion in 2013 to USD 3.5 billion by 2023), demonstrating India's commitment to clean energy.
 - **Reduced subsidies** enabled investments in **alternative energy sources**, such as [LPG](#)


for rural areas, balancing environmental and social goals.

- The **additional revenues** were redirected to fund clean energy projects such as [solar parks](#), [electric vehicles](#), and [grid infrastructure](#).
- **Role of Taxation:** From 2010 to 2017, India imposed a **cess on coal production** and imports, which funded **clean energy initiatives**.
 - Around **30% of cess collections** were allocated to the [National Clean Energy and Environment Fund \(NCEEF\)](#), supporting **clean energy projects** and **research**.
 - The cess significantly bolstered the **Ministry of New and Renewable Energy's** budget, financing key programs like the [Green Energy Corridor](#) and [National Solar Mission](#), reducing **solar energy costs** and supporting **off-grid solutions**.
- **Installed Capacity and Growth:** Renewable energy capacity grew by 24.2 GW (13.5%), reaching **203.18 GW** in October 2024 (up from 178.98 GW in October 2023).
 - **Non-fossil fuel capacity** (including nuclear) rose to **211.36 GW** in 2024, from 186.46 GW in 2023.
 - **Solar power** capacity increased by 20.1 GW (27.9%), reaching **92.12 GW** in October 2024 (up from 72.02 GW in 2023).
 - The country's potential for [solar energy](#) is estimated at **748 GW** by the **National Institute of Solar Energy (NISE)**.
 - **Wind energy** capacity grew by 7.8%, from 44.29 GW in October 2023 to 47.72 GW in 2024.
 - **Large hydro projects** contributed 46.93 GW to the renewable portfolio and **Nuclear power** added 8.18 GW to the total capacity.
 - India ranks **4th globally in total renewable power capacity**, **4th in wind power capacity**, and **5th in solar power capacity**, solidifying its position as a global leader in the renewable energy transition.
- **Renewable Energy Targets:** India has set a bold target to achieve **500 GW of renewable energy** capacity by 2030, a major part of its commitment under the [Panchamrit](#) framework outlined at [COP26](#).
 - The goal is to ensure **50% of the country's total energy mix** comes from renewable sources by 2030.
 - These efforts align with India's broader climate goals of reducing carbon intensity by **45%** by the end of the decade and achieving [net-zero emissions by 2070](#).
- **Green Hydrogen Commitment:** A key component of India's renewable energy strategy is the development of [green hydrogen](#).
 - The government aims to produce **5 million tonnes (MT) of green hydrogen** annually by 2030, supported by a dedicated **125 GW of renewable energy** capacity for hydrogen production.
 - This initiative is expected to position India as a global leader in clean hydrogen production, which is crucial for decarbonizing hard-to-abate sectors like industry, transport, and heavy-duty power generation.

Types of Renewable Energy Sources




①
Hydropower




Gravitational potential energy of water converted into electrical energy through a hydraulic turbine

②
Wind Energy




Kinetic energy of wind converted into electricity by wind turbines

③
Solar Energy



The sun's energy turned into electricity heat energy by solar panels/solar heaters

④
Biomass




Energy obtained from plant & animal remains; e.g, burning wood produces heat energy

⑤
Geothermal Energy




Heat energy trapped underneath the earth's crust converted into electricity by steam turbines

⑥
Ocean Energy



Oceanic thermal and tidal energy converted into electricity by turbines and other systems

⑦
Hydrogen



Hydrogen's potential chemical energy converted into electricity by Hydrogen fuel cells

What are Key Schemes & Initiatives to Boost India's Renewable Energy Sector?

- **Union Budget 2024:** The [Union Budget 2024-25](#) allocates Rs 10,000 crore to the **Centrally Sponsored Scheme for Solar Power (Grid)**, marking a significant **110% increase** from the Rs 4,757 crore allocated in the previous budget.
 - Additionally, the [PM-Surya Ghar Muft Bijli Yojana](#), launched in February 2024 with an overall outlay of **Rs 75,000 crore**, has received **Rs 6,250 crore** for implementation. It aims to promote the adoption of solar rooftop systems.
 - The budget also announces the **exemption of Basic Customs Duty (BCD)** on imports of 25 [critical minerals](#), essential for the growth of the renewable energy sector.
- **PM-KUSUM Scheme:** The [PM-KUSUM \(Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan\)](#) scheme plays a crucial role in promoting solar energy in agriculture.
 - It aims to install **solar pumps and solarized agricultural feeders**, reducing farmers' reliance on grid power and diesel.
 - With a target to install **34.8 GW** of solar capacity through decentralized solar projects, this initiative supports sustainable farming practices and enhances rural energy access.
- **National Green Hydrogen Mission:** India's [National Green Hydrogen Mission](#), with a budget of **Rs 19,744 Cr**, aims to develop a competitive and self-reliant green hydrogen industry.
 - The mission focuses on producing green hydrogen at scale and promoting its use in sectors like **industrial decarbonization, heavy transport, and energy storage**, helping India meet its climate goals while creating jobs and boosting economic growth.
- **Solar Park Scheme:** India has approved **55 solar parks** with a combined capacity of **40 GW** under the **Solar Park Scheme**.
 - This initiative simplifies [land acquisition](#), provides infrastructure, and attracts private investments by offering pre-developed sites for solar projects.
 - It plays a pivotal role in achieving the country's solar energy expansion goals.
- **PLI Scheme for High-Efficiency Solar PV Modules:** To reduce dependency on imported solar components, India has launched the [PLI Scheme for High-Efficiency Solar PV Modules](#), which incentivizes domestic manufacturing.
 - The scheme has a target to build **65 GW** of annual manufacturing capacity by 2026, with a focus on enhancing the efficiency and competitiveness of **India's solar manufacturing sector**.

- **Green Energy Corridor:** The [Green Energy Corridor](#) aims to strengthen transmission infrastructure to efficiently transfer renewable power from energy-rich regions to demand centers.
 - The first phase, covering **eight renewable energy-rich states**, is already underway, with phase II planned to expand transmission networks to other parts of the country, further integrating renewable energy into the grid.
- **Viability Gap Funding (VGF) for Offshore Wind:** The [Viability Gap Funding \(VGF\)](#) scheme supports the development of offshore wind projects along India's coastlines.
 - With a target of **30 GW** of offshore wind by 2030, this initiative focuses on **Gujarat** and **Tamil Nadu** as primary sites for offshore wind farm development, aiming to create a new source of renewable energy generation.
- **International Leadership in Renewable Energy:** India has demonstrated its global leadership in renewable energy through initiatives such as the [International Solar Alliance \(ISA\)](#), which it co-founded with France.
 - The ISA aims to mobilize **USD 1 trillion** in solar investments and facilitate the deployment of **1,000 GW** of solar power by 2030.
 - The idea of [One Sun, One World, One Grid \(OSOWOG\)](#) proposed for the first time, in 2018, at the first assembly of the **International Solar Alliance (ISA)** aims to create a global interconnected renewable energy grid.
 - It involves **three phases:** connecting India to neighboring regions, expanding to Africa, and achieving global interconnection by 2050.

What are Challenges in the Renewable Energy Sector in India?

- **Land Acquisition:** One of the major challenges in the **renewable energy sector** is acquiring sufficient land for large solar and wind projects.
 - Many suitable land areas are either **densely populated** or used for **agriculture**, creating delays in project implementation and escalating costs.
- **Taxation in Clean Energy:** From 2010 to 2017, India levied a cess on coal production to fund clean energy projects.
 - However, the introduction of [GST](#) in [2017](#) subsumed the coal cess into the [GST compensation cess](#), altering fund distribution to offset states' revenue losses.
 - This shift in taxation illustrates the challenges and ongoing adjustments needed to support **clean energy** financing within India's fiscal landscape.
- **Availability and High Cost of Technology:** The renewable energy sector faces significant challenges due to the **high cost** and **limited availability** of critical technologies.
 - **China's reluctance** to provide access to **solar manufacturing technologies** is compounded by the fact that **98% of solar module equipment** is produced in China.
 - India relies heavily on imports for critical components such as solar panels, wind turbine parts, and electrolyzers for green hydrogen.
 - In FY23, **China** made up a staggering **94%** of India's total [solar PV cell imports](#) and **93%** of its [solar PV module](#) shipments.
 - This dependency exposes the sector to risks related to **global supply chain disruptions and price fluctuations**, hindering the sustainability of India's renewable energy growth.
- **Grid Infrastructure and Stability:** India's existing grid infrastructure requires substantial upgrades to integrate large volumes of intermittent renewable energy like **solar and wind**.
 - The lack of adequate storage solutions and flexible grid systems can lead to instability, affecting the seamless supply of **renewable energy**.
- **Financing and Investment:** Despite India's renewable energy growth, **attracting long-term capital** remains a challenge due to **high upfront costs**, constant upgradation of technologies, and concerns over return on investment.
 - The sector's **capital-intensive** nature requires **consistent investment**, but uncertainties regarding policy changes and global economic conditions pose risks to potential investors.
- **Regulatory and Policy Hurdles:** Inconsistent regulatory frameworks and delays in project approvals across states create barriers to the timely development of renewable energy projects.
 - **Streamlining regulations** and improving coordination between the central and state governments are crucial to ensuring faster implementation and fostering investor confidence.
- **Skilled Workforce Shortage:** As the renewable energy sector expands, there is a significant need for a skilled workforce, particularly in areas like **green hydrogen** production, **energy**

storage technologies, and advanced solar and wind technologies.

- Building a robust workforce through training and [skill development](#) programs is essential for sustaining growth in the sector.

Way Forward

- **Land Acquisition:** To address **land acquisition challenges**, India must explore **innovative solutions** such as utilizing **non-agricultural** or **degraded land** for solar and wind farms.
- Promoting **rooftop solar** and integrating renewable energy in **urban infrastructure** can reduce dependency on large tracts of land.
 - Collaborative **land pooling models** and **policy incentives** for landowners can also expedite the process.
- **Taxation in Clean Energy:** The government should revisit the **taxation framework** to ensure that **clean energy projects** receive consistent and sustainable **funding**. Clarifying the allocation of **cess revenues** and enhancing **tax incentives** for renewable energy investments will encourage **long-term financing**.
 - Strengthening the connection between **GST collections** and clean energy subsidies can help stabilize funding streams.
- **Availability and High Cost of Technology:** India should focus on strengthening **domestic manufacturing** capabilities for critical components like **solar panels, wind turbines, and electrolyzers**. This can be achieved through incentivizing **innovation** and production under schemes such as the **PLI Scheme**.
 - Additionally, fostering [public-private partnerships \(PPP\)](#) to reduce dependency on foreign suppliers and mitigate **supply chain risks** is essential.
 - Negotiating **technology-sharing agreements** with countries that have advanced manufacturing capacities could also alleviate the technology gap.
- **Grid Infrastructure and Stability: Upgrading grid infrastructure** to accommodate renewable energy is crucial.
 - The government should invest in **modernizing the transmission network**, focusing on [smart grid technology](#), and incorporating **energy storage solutions** such as **batteries** to handle intermittency.
 - Strengthening **cross-border grid interconnections** can help balance supply and demand across regions, enhancing **grid stability**.
- **Financing and Investment:** To attract more **investment**, India should introduce attractive **financial models**, such as **green bonds** and **renewable energy investment funds**, while ensuring **policy stability**.
 - Clear long-term **incentives**, a reduction in **bureaucratic hurdles**, and **risk mitigation strategies** like [power purchase agreements \(PPAs\)](#) will foster investor confidence.
 - Furthermore, creating a **dedicated green energy fund** can ease the flow of capital into clean energy projects.
- **Regulatory and Policy Hurdles: Streamlining regulatory processes** and creating **uniform policies** across states will expedite **project approvals** and reduce delays.
 - Centralized platforms for **project monitoring** and **approval** can also improve coordination between the **central** and **state governments**, ensuring faster implementation of renewable energy projects.
- **Skill Development Programs:** Expanding training programs for skilled workers in renewable energy technologies will address the sector's labor shortage.
 - Initiatives like [Solar Technology Application Resource Centre \(Star-C\)](#) and vocational training for emerging sectors like hydrogen production and energy storage will build a capable workforce to support the country's **renewable energy transition**.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

Q. 'Net metering' is sometimes seen in the news in the context of promoting the (2016)

- (a)** Production and use of solar energy by the households/consumers

(b) Use of piped natural gas in the kitchens of households

(c) Installation of CNG kits in motor cars

(d) Installation of water meters in urban households

Ans: (a)

Mains:

Q.India has immense potential of solar energy though there are regional variations in its developments. Elaborate. **(2020)**

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