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India's Renewable Energy Revolution — Scale, Gaps, and the Road to 500 GW

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SUBJECTS COVERED

ENVIRONMENT ECONOMY SCIENCE & TECH

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India's Renewable Energy Revolution — Scale, Gaps, and the Road to 500 GW

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WHY IN NEWS

India's installed renewable energy capacity crossed 210 GW in early 2026, placing it 4th globally — as India tracks its commitment to reach 500 GW of non-fossil energy by 2030, a target requiring the addition of approximately 50 GW per year for the next four years.

INDIA'S RENEWABLE ENERGY JOURNEY — THE NUMBERS

India's energy sector is undergoing one of the world's fastest clean energy transitions. The transformation began systematically with the **Jawaharlal Nehru National Solar Mission** (JNNSM) launched in January 2010, which set a 20 GW solar target by 2022 — later revised massively upward.

Historical milestones:

Year	Solar Capacity	Wind Capacity	Total RE
2014	2.6 GW	21 GW	~31 GW (incl. large hydro)
2019	26 GW	37 GW	~82 GW
2022	62 GW	42 GW	~155 GW
2024	100 GW	47 GW	~200 GW
Jan 2026	~100 GW	~48 GW	~210 GW

India crossed **100 GW of solar capacity** in November 2024 — becoming only the 4th country to do so (after China, the United States, and Germany), demonstrating a remarkable acceleration from 2.6 GW in 2014.

INDIA'S 2030 RENEWABLE ENERGY TARGETS

India submitted its **updated Nationally Determined Contribution (NDC)** to the UNFCCC in August 2022, committing to:

- **500 GW** of installed electricity capacity from non-fossil fuel sources by 2030
- **50% of energy** from renewable sources by 2030

- **45% reduction** in the emissions intensity of GDP (from 2005 levels) by 2030
- Create an additional **carbon sink** of 2.5–3 billion tonnes of CO_2 equivalent through forests and tree cover by 2030

India also pledged **net-zero emissions by 2070** at COP26 (Glasgow, October-November 2021) — 10 years later than the 2060 target of China and the 2050 target of major Western economies.

The **500 GW target** requires adding approximately 50 GW of renewable capacity per year from 2026 onwards — a pace India has not yet consistently demonstrated, though 2024 was a record year.

KEY SOLAR MISSIONS AND SCHEMES

PM Surya Ghar Muft Bijli Yojana (2024)

Launched **February 13, 2024**, this scheme provides solar rooftop systems to 1 crore (10 million) households with:

- Up to 300 units of free electricity per month
- **Central subsidy:** Rs 78,000 for 3 kW system; Rs 90,000 for above 3 kW
- Target: 40 GW rooftop solar capacity
- Nodal Ministry: **Ministry of New and Renewable Energy (MNRE)**

National Solar Mission / PM-KUSUM

- **PM-KUSUM (PM Kisan Urja Suraksha evam Utthaan Mahabhiyan):** solar pumps for farmers; feeders; 25 lakh solar pumps target; MNRE
- **Solar Parks:** Ultra-Mega Solar Parks programme — Pavagada (Karnataka, 2,050 MW), Rewa (Madhya Pradesh, 750 MW), Bhadla (Rajasthan, 2,245 MW — one of Asia's largest)

Green Energy Corridor

Green Energy Corridor Phases I and II connect renewable energy-rich states (Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh, Karnataka, Himachal Pradesh) to the national grid — addressing the fundamental challenge that India's best renewable resources are geographically distant from major demand centres.

THE 500 GW CHALLENGE — WHAT NEEDS TO HAPPEN

Land and Grid Infrastructure

Large-scale solar (utility-scale) requires approximately **5–6 acres per MW**. The 500 GW target implies approximately 2.5–3 million acres (roughly 10,000–12,000 sq km) of land for solar alone. Land acquisition, right of way for transmission lines, and state government cooperation are critical bottlenecks.

ISTS (Inter-State Transmission System) waiver: The government extended waiver of ISTS transmission charges for new renewable energy projects — removing a significant cost barrier for developers and enabling RE projects to sell power across state boundaries without transmission charges.

Storage — The Unresolved Problem

India's 500 GW RE ambition faces a fundamental physics constraint: **renewable energy is intermittent**. Solar produces only during daylight hours; wind generation is variable. Without large-scale energy storage, the grid cannot absorb high RE penetration without stability risks.

India's battery storage targets:

- **National Energy Storage Mission (NESM):** 50 GWh storage by 2027; 380 GWh by 2030
- **Viability Gap Funding (VGF):** Rs 9,400 crore for 4,000 MWh battery storage (approved 2023)
- **Pumped Hydro Storage:** India has 4.8 GW operational pumped hydro; significant untapped potential (especially in Himalayan and peninsular river basins); Central Electricity Authority (CEA) estimates 96 GW potential

Green Hydrogen — Future Frontier

National Green Hydrogen Mission (January 2023; Rs 19,744 crore):

- Target: 5 million metric tonnes (MMT) of green hydrogen production per year by 2030
- Target: 125 GW of dedicated renewable energy for green hydrogen by 2030
- Nodal Ministry: MNRE
- Significance: green hydrogen (made by electrolysing water using RE) is needed to decarbonise hard-to-abate sectors — fertilisers, steel, refining, shipping, heavy transport

India's **fertiliser sector** (which uses natural gas-based ammonia/urea) and **steel sector** (which uses coking coal) are the two largest initial target markets for green hydrogen substitution.

INDIA'S RENEWABLE ENERGY ECOSYSTEM

Manufacturing — PLI Scheme for Solar

Production Linked Incentive (PLI) Scheme for High Efficiency Solar PV Modules: Rs 24,000 crore allocation; target: 65 GW of domestic solar manufacturing capacity. Reduces India's current dependence on Chinese solar cells and panels (~70% import share as of 2022).

Power Distribution — RDSS Scheme

Revamped Distribution Sector Scheme (RDSS): Rs 3.03 lakh crore; 2021–2026; aims to reduce Aggregate Technical and Commercial (AT&C) losses (currently ~18–20%) to below 12%; smart metering (250 million smart meters target); Infrastructure upgrades for DISCOMs (distribution companies).

India's **DISCOMs** (state electricity distribution companies) have historically weak balance sheets — accumulated losses of over Rs 4.5 lakh crore. If DISCOMs fail financially, the RE capacity expansion will have no creditworthy buyers. RDSS is the structural fix.

International Context

Country	2030 RE Target	Current Capacity
India	500 GW non-fossil	~210 GW
China	~3,300 GW RE	~1,650 GW
USA	100% clean power by 2035	~370 GW RE
EU	45% RE in energy mix by 2030	~600 GW

China's RE capacity addition in a single year (~300 GW in 2024) exceeds India's total current capacity — illustrating the scale differential.

UPSC RELEVANCE

Prelims:

- India's 2030 NDC: 500 GW non-fossil; 50% from RE; 45% emissions intensity reduction from 2005; net-zero 2070
- JNNSM: launched January 2010 (revised target 280 GW solar by 2030)
- PM Surya Ghar: launched February 13, 2024; 1 crore households; 300 units free/month; 40 GW rooftop target
- PM-KUSUM: solar pumps for farmers; MNRE

Bhadla Solar Park: Rajasthan; ~2,245 MW; one of Asia's largest

National Green Hydrogen Mission: January 2023; Rs 19,744 crore; 5 MMT/year by 2030

National Energy Storage Mission: 50 GWh by 2027; 380 GWh by 2030

ISTS waiver: waiver of inter-state transmission charges for RE projects

RDSS: Revamped Distribution Sector Scheme; Rs 3.03 lakh crore; AT&C loss reduction; smart metering

Mains GS-3: India's renewable energy transition — targets vs. achievement; storage challenge; grid integration; DISCOM financial health; green hydrogen mission; India's net-zero commitment.

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INDIA'S RE CAPACITY (JANUARY 2026):

Solar: ~100 GW; Wind: ~48 GW; Large Hydro: ~47 GW; Total RE: ~210 GW

India rank: 4th globally; 3rd in solar; 4th in wind

India's 100 GW solar: crossed November 2024 (4th country globally after China, USA, Germany)

INDIA'S NDC / CLIMATE TARGETS:

500 GW non-fossil capacity by 2030 (COP26, Glasgow, 2021)

50% energy from renewables by 2030

45% emissions intensity reduction from 2005 levels by 2030

Net-zero by 2070 (announced COP26)

SOLAR SCHEMES:

JNNSM: January 2010; target revised to 280 GW by 2030

PM Surya Ghar Muft Bijli Yojana: February 13, 2024; 1 crore HH; 40 GW rooftop; 300 units free/month

PLI for Solar PV: Rs 24,000 crore; 65 GW manufacturing capacity target

Bhadla Solar Park: Rajasthan; ~2,245 MW; one of Asia's largest

Pavagada Solar Park: Karnataka; 2,050 MW

Rewa Solar Park: Madhya Pradesh; 750 MW

PM-KUSUM: solar pumps for farmers; MNRE

STORAGE / HYDROGEN:

National Energy Storage Mission (NESM): 50 GWh by 2027; 380 GWh by 2030

VGF for Battery Storage: Rs 9,400 crore; 4,000 MWh; approved 2023

Pumped Hydro: 4.8 GW operational; 96 GW potential (CEA estimate)

National Green Hydrogen Mission: January 2023; Rs 19,744 crore; 5 MMT/year by 2030; 125 GW dedicated RE

DISTRIBUTION:

RDSS: Rs 3.03 lakh crore; 2021–2026; AT&C loss target <12%; 250 million smart meters

ISTS waiver: waiver of inter-state transmission charges for new RE projects

DISCOM accumulated losses: ~Rs 4.5 lakh crore (as of 2022–23)

OTHER RELEVANT FACTS:

MNRE: Ministry of New and Renewable Energy (does NOT cover large hydro — Ministry of Power)

India's installed total power capacity (all sources): approximately 980 GW by January 2026

Green Energy Corridor: transmission infrastructure linking RE-rich states to national grid

COP26: Glasgow, October-November 2021; India announced net-zero 2070 and 500 GW targets

Updated NDC: submitted to UNFCCC August 2022

Sources: MNRE, PIB, CEA

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