Review of Future of Wind Energy in India (2026-2047)

[1]DEVANSHU BHURE, [2]GAURI DHORE, [3]JEEWAN BAROLE, [4]HASHER KHAN, [5]JANHAVI TURKAR, [6]OM SOLUNKE

[1]Electrical Engineering / Government College of Engineering /Nagpur, India
[2]Electrical Engineering / Government College of Engineering / Nagpur, India
[3]Electrical Engineering / Government College of Engineering / Nagpur, India
[4]Electrical Engineering / Government College of Engineering / Nagpur, India
[5]Electrical Engineering / Government College of Engineering / Nagpur, India
[6]Electrical Engineering / Government College of Engineering / Nagpur, India

Email id. gauridhore@gmail.com, devanshubhure50@gmail.com, hashirkhan1975786@gmail.com. janhaviturkar06@gmail.com, jeewanbarole@gmail.com, omsolunke04@gmail.com

How to Cite this Article:

BHURE, D., DHORE, G., KHAN, H., TURKAR, J., SOLUNKE, O. & BAROLE, J. (2026). Review of Future of Wind Energy in India (2026-2047). International Journal of Creative and Open Research in Engineering and Management, <i>02</i>(04). https://doi.org/10.55041/ijcope.v2i4.166

https://doi.org/ 10.55041/ijcope.v2i4.166

Abstract

In early 2026,India hit a turning point in how it powers the country, with half ofits electricity capacity now coming from clean sources. T hat progress shows just how fast efforts are moving toward hitting 50 0 gigawatts of renewables by 2030.Wind power plays a big rolehere not only through landbased turbines but also new projects taking shap e at sea.

Looking ahead, wind power in India is shaped by academic studies, fresh policy drafts such as the20 26 Electricity Proposal, alongside feedback from sector experts.

Along the shores of Gujarat and TamilNadu, winds could generate nearly 70 gigawatts at sea enough to mark a major shift. Still, rolling out massive projects runs into hur dles not just engineering gaps but also weak backbone networks on l and and under water. Moving electricity efficiently will demand tools likehighcapacity DC lines, especially where cables must cross ocean floors.Still new in India's energy mix, offshore wind power costs arou nd Rs9.6 to Rs10.8 each kilowatthour. Pricier thansolar or landbased turbines, yet support like financial aid and risk controls could lower e xpenses over time. Rules have shifted since the2015 offshore plan, no w pushing faster permits and sea leases by 2026. Simpler approvals a im to pull in business investment without heavy state spending. Prog ress hinges less on tech, more on how smoothly rules turn into real projects.One way to see 2047 is through cleaner power lines humming with wind and sun working together, not side by side but as one flow only if outdated grids get fixed step by step. Winds then do more than blow the y carry load once left only to sunlight. Progress depends less on speed than fixing how energy moves across regions. Without upgrades, even strong breezes won’t reach homes.A century after freedom, electricity could r un free of carbon if systems now holding it back begin to shift.

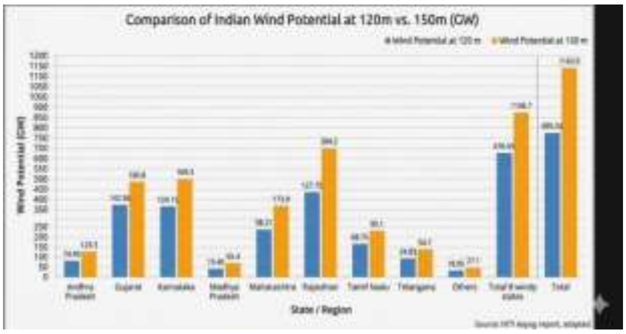
KEYWORDS : Wind Energy in India , Offshore Wind Power, Renewable Energy Integration, Grid Infrastructure and HVDC, Levelized Cost of Energy (LCOE), Energy Policy and Regulation, Sustainable Energy Transition.

INTRODUCTION

Midway through 2026, India hits a milestone over half its power now comes from sources that do not burn fossil fuels. This shift stems from growing ne ed for electricity and promises made abroad to cut emissions. Though solar gets attention, wind
has long played a key role across the nation’s inland regions. Yet reaching 500 gigawatts of green powe r by2030 means looking beyond familiar ground. Fresh efforts are turning seaward, where winds blo w stronger and more steadily. At the same time, ag ing turbines on land are being replaced with smarte r, larger models to squeeze more output from existi ng site.
Windenergy matters because it works when solar does not. When the sun sets, turbines keep spinni ng, especially at night and in monsoon months w here sunlight fades. These shifting patterns help bal ance electricity supply as renewables take up more space on thegrid. Instead of following predict able rhythms, output shifts with weather, time, across seasons. Progress ahead depends les s on ideas than on real changes in technol ogy, cost structures, rules. Each part machin es, money, laws shapes how fast things move beyo nd today’s starting point in 2026 toward what comes by 2047.

More people need electricity now, yet worrie s about dirty air are pushing nations to try greener ways of making power. Instead of relying only on o ld methods, some places are turning to nature-driven solutions. Wind
power stands out among these, working well even a t massive scales without wearing out. Across wide s tretches of land, spinning
turbines pull energy straight from moving air. In In dia, harnessing gusts helps replace coal plants whil e cutting down harmful emissions.
The shape ofthe land there, along with steady mons oon winds, creates ideal spots for capturing ai rflow. Because of this advantage, tall masts with rot ating blades appear more often on open horizons. These structures quietly feed supply into grids t hat serve cities and villages alike. Over time, they’r e helping balance environmental targets with stable access to lights, machines,and cooling systems. Reaching future promises around cleaner skies me ans building more of them carefully.

Windenergy projects are growing fast nationwide, r ecent updates show. Beyond two dozen states i n India have now locked in deals for over 100 giga watts of wind capacity by 2030, mainly to fulfill renewable targets and broad en green power sources. Leading that shift: regio ns blessed with strong breezes - Gujarat, Tamil Nadu, Karnataka, and Rajasthan. Yet here's something else happe ning quietly places where winds blow less steadil y, like Odisha, Jharkhand, Punjab, andBihar, still want in. Instead of building larg e farms locally, they’re lining up to receive extra el ectricity from windy zones using shared long-distance lines.



2. Methods and Approaches in the Sources

From academic papers to realworld tests, insig hts come through layers of review.
Feasibility trials sit beside government memos, eac h adding weight.
Recentpolicy texts appear alongside research journ als, forming a base. Scholarly work feeds into asses sments that shape what follows. Studies blend w ith official records, not just stacked but woven. E ach piece connects without force, yet holds fir m Studies led by Rathinaveland team in 2021, along with work from Singhcolleagues in 2023, lay out how wind powe r could shape climate strategies across India[1],[2].Starting with realworld numbers from places suc h as Kanyakumari and Rameshwaram, studies led b yAlluri and team in 2017and 2018 built detailed as sessments. These reports dig into energy costs usin

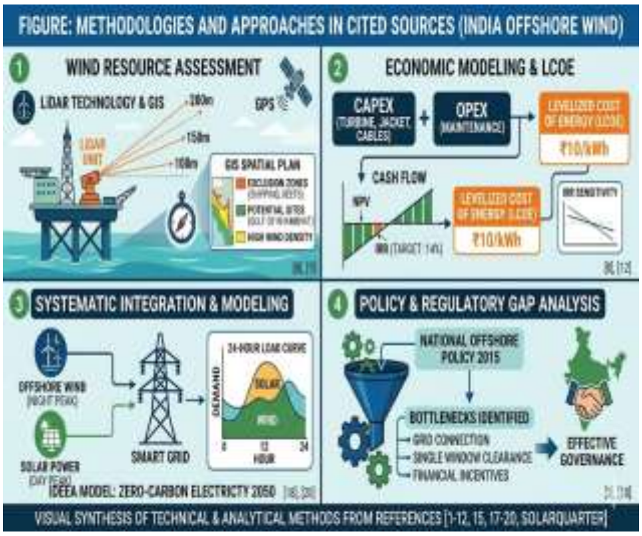
g a measure called LCOE - levelized cost of energy. Instead of guessing, they rely on actual local conditions to shape their findings. Financial returns appear through IRR calculations, giving a clearer picture of project potential. Work from those years forms part of references eight and nine, backing claims with fieldbased inputs.Starting off, a look at India's offshore wind energy policy from 2015 helps show where goals began. Then came the draft lease rules in 2019 these laid out how companies might rent sea areas for turbines. Following that,the latest electricpolicy proposal in 2026 adds updates on power distribution plans. Together, these papers sketch what agencies are supposed to do. References [3] and [17] back up each point made along the way.

Starting off differently - projections using the IDEEA framework from Lugovoy and team in 2021 explore how India might run entirely on clean power by midcentury. These simulations spotlight ways that wind plus sunlight could work together across regions. Because timing matters, shifts in output are balanced through geographic spread rather than relying on single sources. What stands out is how pattern of generation align when matched smartly

across states. Instead of stacking technologies separately, their overlap creates steadier supply. While challenges remain, this approach reduces dependency on storage. Ultimately, coordination between zones emerges as key under these modeled pathways.MidMarch2026 updates from SolarQuarter show India's power mix now half nonfossil.

Progress continues pushing toward next decade goals. Momentum builds without relying on coalheavy systems. Shifts appear across regions adopting cleaner setups. Milestone marks a turning point seen through project rollouts. Data reflects changes underway beyond policy talk. Movement forward stays visible in daily operations. Targets once distant now feel within reach. Growth patterns suggest longterm change is taking hold.

Starting off, most studies apply LiDAR scans to map coastal features across India. Instead of guessing, they track physical assets using spatial data tools. One step further, analysts calculate setup costs alongside running expenses. Taken together, these steps form a grounded picture of project demands. Notably, past work builds on such combined technique. Often, locationbased inputs shape financial forecasts.In practice, this means terrain guides budgeting. Another point: elevation details affect planning depth. From there, numbers feed into broader models. Rarely does any factor stand alone. Usually, layers of info merge for clarity. Ultimately, method shapes outcome.



3. Technological Innovations and Infrastructure

3.1 off shore wind potential

Offshore winds around India hold huge power, yet barely touched so fara quiet giant in the country's energy plans. Hundreds of gigawatts could be possible just in waters between zero and fifty meters deep [11]. Instead of vague guesses, real studies from NIWE point to more than 70,000 megawatts ready for capture, most near Gujarat's shores with 36 gigawatts, followed closely by Tamil Nadu at 35 [6], [15]. Go wider in thinking,
some figures stretch that ceiling anywhere 500 gigawatts; still, solid proof on exact spots has not caught up yet [17].

Along Gujarat's shore, especially near the Gulf of Khambhat and the Gulf of Kutch, strong port setups make growth easier. These areas also benefit from power lines that were built earlier, working better right now than similar syste ms down south in Tamil Nadu [11],[15]. Work has started where conditions align best spots once scanned by airborne sensors mappi ng how much wind flows through them [2].

3.2 Turbine Advancements and Foundation

Shifting from landbased to seabased wind power ch anges how turbines are built and moved into place. Instead of sticking with the older 23 megawatt mod els common across India's terrain, going offshore means choosing bigger machines.
High setup expenses at sea make efficiency crucial. By 2021offshore turbines worldwide averaged 7. 4 megawatts in output. Because space on the ocea n floor matters, new Indian plans skip intermediate sizes altogether.
Projects now aim straight for 10to 15 mega watt systems. That jump helps capture more electric ity without needing extra room. Each unit placed do es heavier lifting than its inland cousins ever coul d.
What holds turbines upright matters just as much. In the shallower zones near India’s shoreline z ero to fifty meters deep the go to solution rests on seabed anchored structures. Think steel piles driven into t he ocean floor, or widelegged jackets locking units in place.
Standing tall in shallow waters,monopiles domi nate offshore sites worldwide. Usually seen where the sea floor stays within 30 meter deep, these steel giants hold turbines firm. Their widespread use comes from straightforward installation slam them into the seabed and build upward. Thou gh limited by depth, they remain a goto choice acro ss many coastlines.Standing strong where the water hit 30 to 50 meters,jacketfoundations hold firm eve n when the ground below shifts unpredictable.Stabil ity comes naturally here, thanks to their rigid frame locking into uneven seabeds without hesitation .Piled foundations aren’t always possible underw ater. Where the seafloor won’t allow it,gravit ybased setups step in instead. These rely on weig ht alone to stay put. Location limits shape which m ethod works best. Some ground just can’t take

driven piles. Heavy structures anchored by mass o ffer another path.Conditions below dictate what goes above.
By 2047, tapping into stronger, steadier winds mean s heading past the 50-meter depth - floating turbines make that possible [12], [17].

3.3Grid Integration and HVDC

Not every wire can handle sudden surges from gust y seasons. When storms roll in, turbines spin fast fl ooding lines that struggle to move all that juice at o nce. Heavy flows pile up, especially when rains l ast weeks on end. Some electricity gets cut off simp ly because there’s nowhere for it to go. Bottlenecks appear where infrastructure lags behind turbine gro wth.

Facing such challenges, big ocean setups would need extensive planning. Yet solutions might emerg e through careful testing. Still, real progress depe nds on solid groundwork. Even so, success often f ollows consistent effort. Only then can results b ecome visible.

Underwater wires move electricity from offsho re sites. These cables handle 33kV or 66kV, built for tough ocean conditions. Power trave ls through array links before reaching longdistanc e export lines. Strong insulation protects against s alt water damage. They stretch across seabeds connecting turbines to land stations. Voltage levels depend on project needs and distance. Installation r equires careful planning and precise placement . Maintenance access is limited once submerge d. Protection layers guard against shifting sedi ments and marine activity.

Power lines that carry electricity straight no flippi ng back and forth are key when sending energy acr oss big stretches of land.
From seaside setups pushing juice toward factories deep inside the country, these links lose less power along the way. They also help keep the whole netw ork steady, avoiding messy wobbles in supply. Wi thout them working well, India's plans to grow of fshore wind simply stall out [1], [4].
Morning winds fade, yet power keeps flowing when batteries hold the extra juice.
Draft plans for 2026 spot this fix clearly stora ge backs up breezes. Pump water uphill during gust s, send it down later to spin electricity anew. Spikes and dips in airflow matter less once tanks or cells smooth the flow. Talk among officials now leans this way, guided by recent signs.

4. Policy and Regulatory Framework

4.1 National Targets and the 2026 Milestone

One step at a time, India moved its wind energ y goal forward what began as 60 gigawatts by2022 now stretches toward 140 to 150 gigawatt s by2030. Reaching halfway there,March2026 ma rked a quiet turning point: half of the nation's p owercapacity came from sources that do not bu rn fossil fuel. That shift didn't shout; it simply open ed the door wider. Ahead lies more space for turbines, fewer limits.

4.2 The Draft Electric Policy 2026

A fresh approach shapes how India plans its power future through the Draft Electric Policy 2026. Though longrange details remain uncle ar, focus lands firmly on hitting 500 gigawatts by20 30. Instead of just building more plants, it pushe s smarter setups where batteries join solar an dwind arrays. Because sunshine fades and winds p ause, mixing in
storage helps keep supply steady. Outdated turbine sites aren't ignored either older machines can mak e way for stronger models. Swapping them ou t lifts output without need
ing extra space, especially where breezes blow s trongest [3], [5].

4.3 Institutional Drivers: MNRE and NIWE

The Ministry of New and Renewable Energy (MNRE) serves as the nodal agency for policy formulation, while the National Institute of Wind Energy (NIWE) handles technical assessments and resource mapping.
One key department shapes energy rules, where as another focuses on testing wind strength and charting suppl zones. A
national plan from 2015 sets ground rules for buildi ng projects at sea under Indian control. Lately, offic ials invited interest
in a large oceanbased power effort off Gujar at's coast marking the first move
toward big offshore ventures

5.Economic Feasibility and Financing

5.1 LCOE Benchmark

The Levelized Cost of Energy (LCOE) is the most critical metric for assessing the commercial viability of wind energy in India.
What it takes to produce power shapes how we ju dge wind energy's role across India. Though lan dbased turbines now stand strong against older for ms like coal and gas, sea-driven systems are just finding their footing. Near Kanyakumari, numbers hover near Rs
9.6 per unit, while farther at Rameshwaram they climb to Rs10.8 this under a projected returnof14 %. Behind these figures sit heavy initial investment s, ongoing upkeep, plus unique ocean-
linked transport demands.
Downward shifts in worldwide offshore energy cost s show up clearly when comparing past and present numbers prices fell from about $0.16 per kWh bac k in2010to just $0.05$0.08 lately in certain regi ons [17]. Reaching those lower levels in India? That depends heavily on expanding domestic production of key parts such as massive turbineblades, support towers, even underwater cabling systems [11], [17].

5.2 Incentives and Market Models

One way to close today's gap in price betw een off shore wind and other clean energy sources is through smart finan cing tools. Where markets alone fall short, upd ated pricing models can help level the playing fiel d. Instead of waiting for natural shifts, target ed incentives might adjust investor behavior e arly on. Because infrastructure costs remain hig h, new funding approaches could ease initial burden s. When policy aligns with realworld economics,

A chunk of cash from the government steps in when offshore ventures cost too much upfront. This back ing helps private players get finance
ing by reducing early financial risk. Without it, man y projects would stall before breaking water.Suppo rt like this targets only those proposals that str uggle to attract investors on their own.The aim is c lear: bridge the gap
between expense and feasibility without distort ing market choices.A fresh approach to ocean floor access has begun. Instead of one-size-fits-
all rules, options are being weighed -
one locks in rights, another leaves them open.
Competition gets a nudge this way.
Early exploration becomes less risky under these set ups. Choices shape how sites get tested first. Sour ce points to shift in strategy [1].
Back in the day, wind power got a boost from a 50 paise per unit reward.Some places stopped of fering it. That shift made building new landbased t urbines tougher, reports show.
A fresh wave of funding flows into shorelines and s eabased power systems through global greenbond s, while targeted investments in the socalled BlueEc onomy open new paths. These financial streams sup port offshore energy projects by blending enviro nmental goals with oceanfocused economic models, drawing capital beyond traditional sources.

International markets respond slowly, yet steadi ly, shifting attention from landlocked schemes to ward floating platforms and tidal networks backed b y ecominded debt instruments
.One big change lately? Competitive auctions inste ad of fixed FeedinTariffs prices dropped, sure, yet profits for project builders got squeezed tight. The Draft Electricity Policy 2026 notices this pinch, aiming to smooth thin gs out down the line [3], [5].
progress tends to stick longer.

6.Challenges and Bottlenecks

6.1 Technical and Logistic Barriers

Large-scale wind deployment faces significant on-the-ground challenges:
Far from cities, windy spots in places such as Tamil Nadu and Rajasthan struggle to send power due to weak lines. When the network hits its limit, turbines stop runni ng even if the wind blows hard simply because there is no way to carry the electricity [5], [19].
Facing saltwater rust and yearly storms shapes how ocean work survives. Heavy gear needs strong doc ks, but Indian ports can't manage machines bigger than 10 megawatts. There are no custom ships there either to set up big sea-based energy systems.
When sunlight and wind power make up a big part of electricity by2030, handling their ups and down s becomes essential. Flexibility needs grow fas t so systems must adapt using tools like shifting w hen people use power or saving extra supply for la ter. Storing energy takes center stage because it h elps balance times when renewables generate to o much or too little. Without steady backup plans, s udden drops in sun or wind could disrupt the grid.
Smarter grids respond quicker, adjusting flow based on realtime conditions rather than fixed patterns. In vestment follows where reliability is weakest stora ge and responsive demand stand out as key supp orts.

6.2 Regulatory and Financial Hurdles

Starting off,stateregulators hold the key to turning b road goals into real results. Yet shaky finances at local power companies could still trip up progress down the line. These weak balance sheets stand i n the way more than anything else when it come s to lasting change across the system.Farms giving way to turbines means changes for folks living near by. Power upgrades at old spots need clear talk

s about who owns what. People's lives shift wh en construction rolls in. Agreements must reflect h ow work affects daily routines. Trust grows where v oices are heard early. Projects altering landscapes d emand respect for community rhythms. Clari ty around benefits helps ease transitions. Relations hips matter as much as machinery placement.Still w aters run deep when it comes to offshore work laye rs of rules stack up from sea, sky,and soil. One b ody must pull them together, now shaping that ro le more clearly under MNRE guidance [3], [17].
Offshore ventures demand heavy initial spend ing, which ties their success closely to how expen sive it isto borrow money. When policies are predictable and energy reserves are backed by so lid numbers, confidence grows among big finan cial backers who plan decades ahead [3], [10].

7.Future Directions and Research Gaps

7.1 Path to 2047

When India nears 100 years of independence by 2 047,the goal stands clear electricity with out carbon. Reaching it means shifting how power flows across the nation. One step leads to another, each tied to choices made today. Progress depends on steady changes in energy sources. Old methods fade as new ones take root slowly. What works no w might not hold later. Still, direction matters mor e than speed. Clarity comes from action, not plans a lone. The path forward builds while being walked Deep-water Offshore: Moving beyond 50m depths using floating foundations.
Wind energy splits water into hydrogen throu gh electrolysis. This clean fuel replaces fossil fuels in heavy industries.
Steel production runs on it instead of coal. Ceme nt factories begin using the gas too.
Power from turbines drives the chemical proce ss. Factories cut emissions by switching sources. Th e method links renewable supply toindustrial demand. No carbon released when burn ing green hydrogen. Infrastructure adapts slowly to handle new flows. Energy shift happens piece b y piece.Grid Modernization: Massive expansion of HVDC corridors and the integration of AI-driven grid management systems [20].

7.2 Identified Research Gaps

Even so, some holes still show up in what we know right now.A look ahead shows numbers stretching i nto the future. By 2030, most research lands fi rmly in view. Beyond that point, details grow thi n.Few models map out how much power we might tap by 2047. Even fewer trace the cost path of that e nergy. Data fades the further it reaches.
Though a few papers mention ecological changes, s olid data on how massive offshore wind farms affect ocean life in India's exclusive eco nomic zone over time remains missing [12], [17].
Not having a firm plan makes it unclear who cover s costs for underwater power lines reach ing land. When rules are missing, questions grow about responsibility for moving seabased energy as hore. Without specific guidance, funding the cab le stretch from ocean projects becomes uncertain.
Who steps up financially often depends on gaps in current policies. Right now, no solid framework answers that directly.

8.Conclusion

Wind energy in India stands at a turning point. Reaching half of power supply from non-fossil sources by 2026 shows serious intent toward cleaner energy. Onshore projects keep delivering steady, affordable electricity - thanks to upgrades and fresh builds - yet real change may come from waters off the coast. Offshore wind holds vast promise, especially along Gujarat and Tamil Nadu, where 70 gigawatts could one day flow. Making that happen demands tight coordination: bigger turbines meet smarter grids, financial safeguards pair with ocean-focused investment tools, rules adapt swiftly. Behind it all, fixing how power enters the network - and making utility_providers stronger - will shape whether India hits 500 gigawatts by 2030, then reaches zero emissions two decades later.

9. References

[1] Rathinavel et al., "Offshore wind energy in India: A comprehensive review and strategic prospects," Journal Name Not Available, 2021.

[2] Singh et al., "India's Potential of Wind Energy and Prospects for Climate Change Mitigation-A Review," Journal Name Not Available, 2023.

[3] Kumar et al., "An overview of wind energy development and policy initiatives in India," Clean Technologies and Environmental Policy, vol. 24, pp. 1-20, 2022. DOI: 10.1007/s10098-021-02248-z

[4] Rathinavel et al., "Technical bottlenecks and grid integration for India's wind sector," Insights File, 2026.

[5] Kasisomayajula, "Compressive Study on Importance of Wind Power in India," Journal Name Not Available, 2013.

[6] Singh, "Scenario of Offshore Wind Power Generation in India," Journal of Mechanical and Construction Engineering (JMCE), vol. 3, no. 1, 2023. DOI: 10.54060/jmce.v3i1.28

[7] Gautam et al., "Offshore Wind Technology of India: Potential and Perspectives," Journal Name Not Available, 2025. DOI: 10.1016/j.uncres.2025.100150

[8] Alluri et al., "Offshore Wind to Meet Increasing Energy Demands in India," Current Science, vol. 113, no. 4, pp. 774-781, 2017. DOI: 10.18520/CS/V113/I04/774-781

[9] Alluri et al., "Offshore Wind Feasibility Study in India," IntechOpen, 2018. DOI: 10.5772/INTECHOPEN.74916

[10] Krishnan et al., "Winds of Change: Learnings for the Indian Offshore Wind Energy Sector," World Resources Institute, 2022. DOI: 10.46830/wriwp.21.00106

[11] Yates et al., "Indian offshore wind: ambitions, opportunities and challenges," Engineering & Technology Reference, 2012. DOI: 10.1049/ETR.2016.0114

[12] Kumar et al., "Offshore wind energy status, challenges, opportunities, environmental impacts, occupational health, and safety management in India," Energy & Environment, vol. 32, no. 5, 2021. DOI: 10.1177/0958305X20946483

[15] Tabassum et al., "Renewable energy Sector in Gujarat, India," Journal of the University of Shanghai for Science and Technology, 2021. DOI: 10.51201/JUSST/21/05401

[17] Voyer et al., "Blue Economy and Blue Finance: Toward Sustainable Development and Ocean Governance," Journal Name Not Available, 2022. DOI: 10.56506/hdlz1912

Indian Power System," Springer Nature, 2022. DOI: 10.1007/978-3-658-38215-5_7
[18] ddsd, "Integrating Wind and Solar in the
[19] Aithal, "RENEWABLE ENERGY (For Maintaining Sustainable Society)," Zenodo, 2023. DOI: 10.5281/zenodo.8151850

[20] Lugovoy et al., "Towards a Zero-Carbon Electricity System for India in 2050: IDEEA Model-Based Scenarios Integrating Wind and Solar Complementarity and Geospatial Endowments," Energies, vol. 14, no. 21, 2021. DOI: 10.3390/EN14217063

[SolarQuarter 2026] "India Achieves 50% Non-Fossil Power Capacity, Advances Toward 500 GW Renewable Target by 2030," SolarQuarter, March 17, 2026.