Hochschule Flensburg
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Wind Energy Technology Institude
Research on wind Energy

Wind Farm Project in Gujarat, India

Wind Farm Project Development, WiSe 2024/25

Master's degree in Wind Engineering, Flensburg, Germany

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1. Abstract

- Overview of the Project, Key Findings, Recommendations

2. Introduction

2.1 The Evolution of Wind energy in India

India has made significant wind energy farm over the past few decades, becoming Globally, India ranks fourth in terms of installed wind power capacity. The journey began in the 1980s with small-scale wind energy projects. The first wind farm was established in 1986 in coastal Gujarat. India has developed several large wind farms, particularly in states like Tamil Nadu, Gujarat, and Maharashtra. The growth of the wind industry has created a strong support system, improved project management skills, and built a manufacturing capacity of around 15,000 MW per year. [1] [2]

2.2 Importance of Wind Energy in Gujarat

As of May 2024, Gujarat has an impressive 11,823 MW of installed wind power capacity. This makes it the leading state in India for wind energy, surpassing Tamil Nadu, which has 10,743 MW. [3] Its growth has been significantly influenced by a dedicated wind and land policy, which is further explored in a later section of this report.

No	State	Wind Potential at 120 m (GW)	Wind Potential at 150 m (GW)
1	Andhra Pradesh	70.90	123.3
2	Gujarat	142.56	180.8
3	Karnataka	124.15	169.3
4	Madhya Pradesh	15.40	55.4
5	Maharashtra	98.21	173.9
6	Rajasthan	127.75	284.2
7	Tamil Nadu	68.75	95.1
8	Telangana	24.83	54.7
9	Other	18.95	27.1

*(Table 2 1: **Potential of Wind Energy in Gujarat, India)** [1]*

2.3 Objectives of the Report

- To analyse the growth and current status of wind energy installations in Gujarat, India.
- Design and analyse of Wind Farm using GIS and Wind Pro software
- To examine the policies and regulations that have supported the development of wind energy in Gujarat
- To identify the key drivers and barriers to the expansion of wind energy in Gujarat, India, including infrastructure, financing, and policy support.
- Making schedule and timetable for wind Farm development project in Gujarat, India.

2.4 Scope and Limitations

2.4.1 Scope:

- **Geographic Advantage**: Gujarat's long coastline and favorable wind conditions make it an ideal location for both onshore and offshore wind projects. [4]
- **Government Support**: The state government offers various incentives, including subsidies, tax benefits, and streamlined approval processes, to encourage investment in wind energy.
- **Economic Impact**: Wind energy projects create jobs, boost local economies, and contribute to sustainable development goals.

2.4.2 Limitations:

- **High Initial Costs**: The setup and installation of wind turbines and related infrastructure require significant upfront investment.
- **Land Use Conflicts**: Large-scale wind farms can lead to land acquisition issues and conflicts with local communities.
- **Environmental Concerns**: Wind turbines can impact local wildlife, particularly birds and bats, and may cause noise pollution.

- **Grid Integration**: Integrating wind energy into the existing power grid can be challenging due to the need for stable and reliable energy supply. [5]

3. Literature Review

3.1 Wind Resource Assessment of Gujarat

The wind resource estimates in this study highlight regions with average annual wind speeds above 8 m/s, mainly in the Gulf of Kutch and the southern coast. Similar to past research, our 2011 analysis confirms the highest wind potential in the northwestern Gulf of Kutch, with comparable potential found along the southern coastline. While the International Renewable Energy Agency agrees on high wind speeds in these areas, they report higher speeds of 9 m/s in the Gulf of Khambhat, exceeding our estimates. [4]

Wind speeds in Gujarat peak from May to August, reaching over 10 m/s, particularly along the coast, and are lowest in October and November, averaging below 7 m/s. Gujarat has a tropical and subtropical steppe climate, with occasional cyclones, droughts, and floods. The state experiences three main seasons: winter (November-March), summer (March-June), and monsoon (June-September). The northern region is dry, while the southern part is humid, with coastal winds influenced by sea breezes. [4]

3.2 Review of existing wind energy projects.

3.2.1 Scaling challenges in Gujarat

Renewable energy development, particularly large-scale wind farms, faces multifaceted challenges (Land Acquisition and local engagement, Logistical Challenges, Grid Integration, Regulatory and Environmental Hurdles, Financial and Contractual Risks, Stakeholder Coordination) that can significantly impact project timelines, costs, and outcomes. The experiences of hypothetical projects like Adani Wind Energy's 300 MW wind farm in India's coastal region highlight key obstacles that often arise during such ventures. Successful wind energy projects, such as those proposed by Adani Wind Energy, provide valuable lessons for future initiatives in the renewable energy sector. [6]

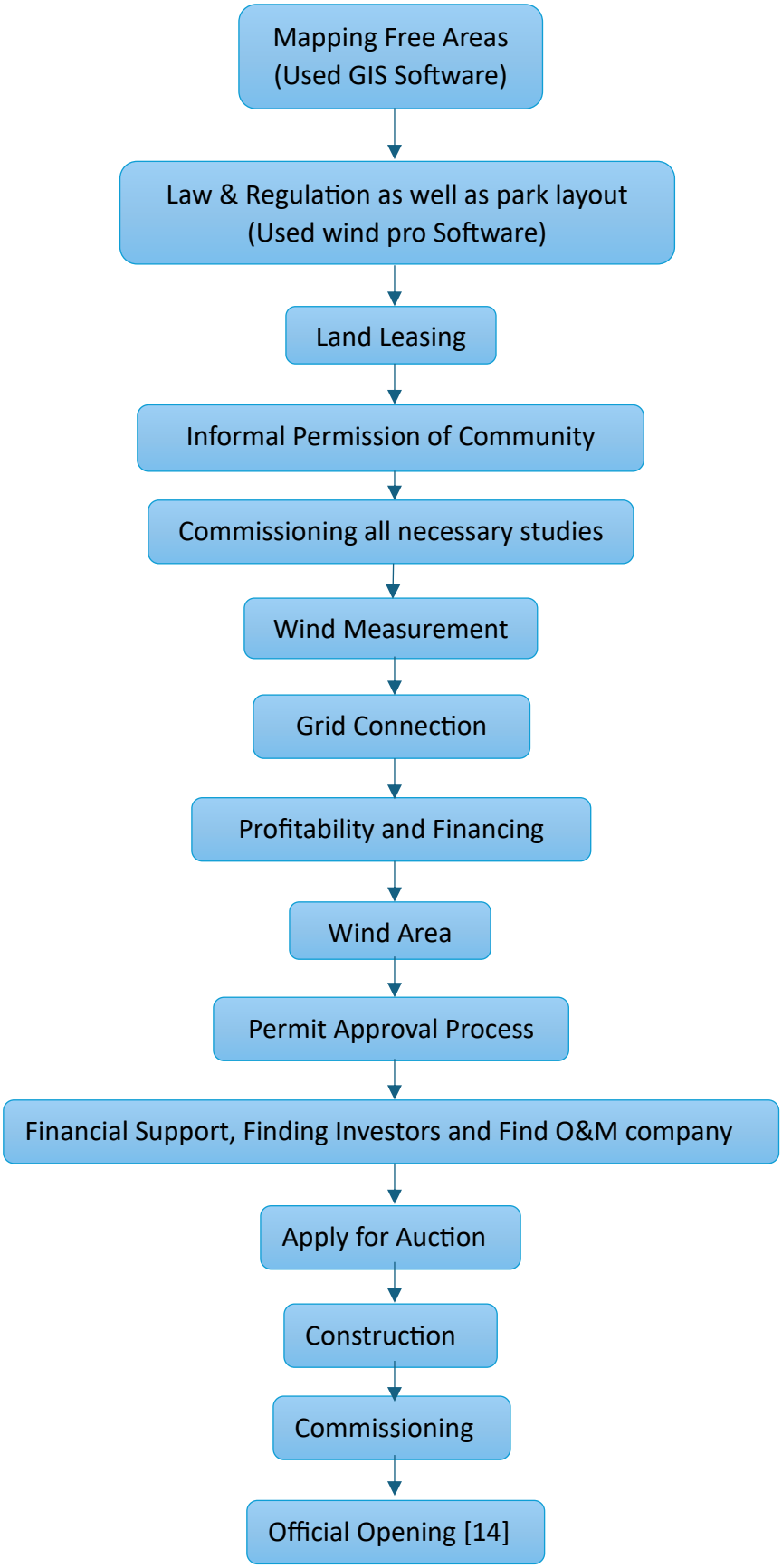
3.2.2 Suzlon secures a repeat order of 193.2 MW in Gujarat

Suzlon Group, a leading renewable energy solutions provider, has secured a repeat order from The KP Group for a wind energy project in Gujarat. This collaboration underscores the private sector's commitment to sustainable growth, supported by Gujarat's favourable policy environment for renewable energy development. Suzlon's wind turbines, featuring the advanced Doubly Fed Induction Generator (DFIG) technology, efficiently integrate with utility

networks to meet grid requirements. The company's R&D focuses on increasing turbine performance, optimizing energy capture from low wind sites, and reducing energy costs. Suzlon’s commitment to **"Aatmanirbhar Bharat"** is evident through its domestically manufactured turbines, contributing to India's self-reliance in the renewable energy sector.

Gujarat's conducive policy environment for renewable energy development, along with Suzlon’s technological expertise and KP Group's commitment, makes the state an ideal location for expanding renewable energy infrastructure. The partnership supports India's net-zero goals while promoting economic progress through clean energy. [7]

4. Methodology



5. Pre-Processing

5.1 Site Selection and Mapping

To promote the healthy and structured growth of the wind power sector in India, the Ministry of New & Renewable Energy (MNRE) introduced guidelines for wind power project development in July 1995, which have been periodically updated (Last updated 2024),. In light of advancements in technology, new regulations, and the need for accelerated growth in the sector, the MNRE has recognized the importance of issuing comprehensive guidelines for wind power project development in collaboration with various stakeholders.

The process of wind power project development starts with site selection. Identification of suitable sites depends upon land use permission, availability of wind resource, technically and commercially feasible grid connectivity, transport logistics and environmental acceptability.

a) Land use permission
b) Availability of wind resource
c) Technically and commercially feasible grid connectivity
d) Transport logistics
e) Environmental acceptability

Guidelines for Micro siting of wind turbines (MNRE)

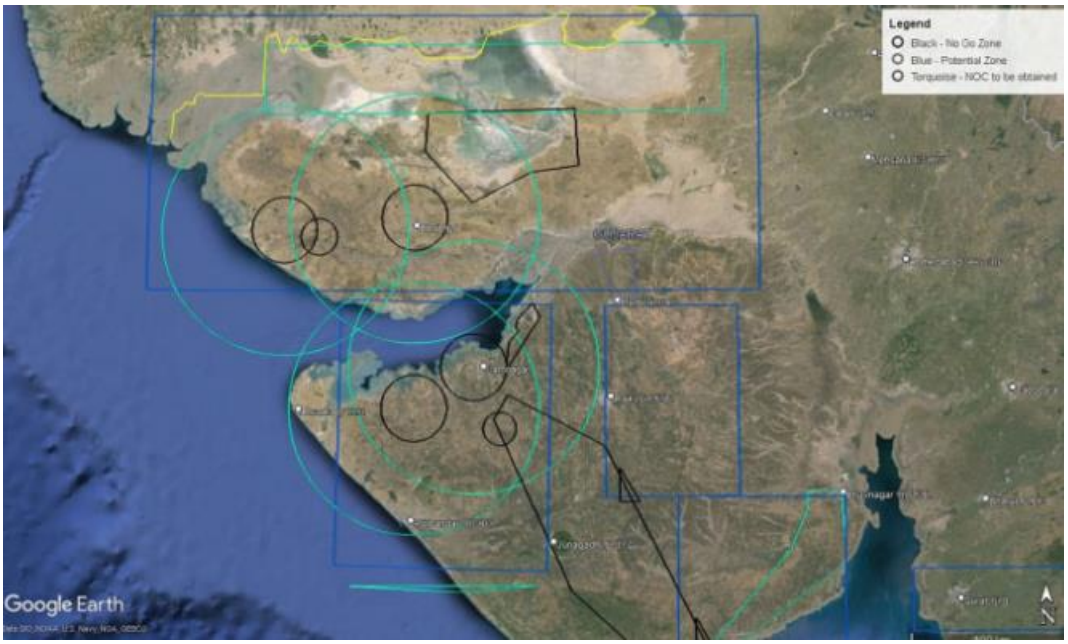
Micrositing is the optimization of energy production through the correct placement of wind turbine generators in the wind farm area, considering all physical constraints of the area.

Micrositing criteria are prescribed as under.

1. Developer(s) shall optimise the wind turbine locations within their land using appropriate wind flow modelling and optimisation tools (linear and Nonlinear)/techniques subject to site assessment as per IEC 61400-1 standard for turbine safety considering extreme wind, flow inclination, vertical wind shear, and turbulence with added wake effects and corrections for terrain complexity etc.
2. Developer(s) shall maintain a distance of 2 x D (D-Rotor Diameter) distance perpendicular to the predominant wind direction and 3 x D distance in the predominant wind direction from the boundary line of each adjoining land of other developer(s) with appropriate offset.
3. Developer(s) shall maintain a wake loss (in terms of energy) of 10% between wind turbines with appropriate offset for wind turbines sited on a footprint basis.
4. Developer(s) shall maintain a distance of HH+1 2 RD+ 5m (Hub Height+ Half Rotor Diameter +5 meters) from Public Roads, railway tracks, highways, buildings, public institutions and EHV lines.
5. Developer(s) shall not site wind turbines within 500 m of any dwelling for the mitigation of noise. ‘dwelling’ shall mean at least 15 inhabited buildings. [7.1 Clarification to the ‘Guidelines for Development of Onshore Wind Power Projects’ and amendments , MNRE, 23.08.2024]

No go Zones declared by Ministry of Defence and MNRE

Ministry of Defence (MoD), in collaboration with the Ministry of New and Renewable Energy, recently issued guidelines identifying specific no-go zones for constructing wind power projects in states with significant wind energy potential. This initiative aims to safeguard wind farm operations from potential risks in the future. It also enhances transparency, ensures more accurate assessments, and facilitates the faster processing of applications for wind energy projects



No Go Zones by MoD and MNRE, https://renewablewatch.in/2024/06/05/setting-boundaries-implications-of-the-demarcation-of-no-go-zones-for-wind-projects/

The policy move will reduce the risk for developers due to the newly available information on where a project cannot be set up. However, a significant portion of potential wind energy zones, which otherwise had very good potential, must now be avoided due to this demarcation.

Blue polygons represent Wins potential zones, The black polygons represent no-go zones, while turquoise represent areas where NOC need to be obtained from MoD or MNRE.

(Source:- *https://renewablewatch.in/2024/06/05/setting-boundaries-implications-of-the-demarcation-of-no-go-zones-for-wind-projects/)*

5.2 Law & Regulation as well as Park Layout

1. Consent to Establish (CTE) from Gujarat State Pollution Control Board (GPCB)

Consent to Establish (CTE)

Required to obtain CTE under section 21(1) of the Air (prevention and control of pollution) Act, 1981. Also, CTE under section 25/26 of the Water Act is required in case of discharge of sewage or trade effluent in a stream or a well or a sewer or a lake.
[section 21(1) of the Air (prevention and control of pollution) Act, 1981]

Consent to Operate (CTO)

Prior to commercial generation, it is obligatory to apply for CTO under section 21 of the Air (P & CP) Act 1981, with respect to ambient air quality related to noise. [section 21 of the Air (P & CP) Act 1981,]

Apply for Hazardous Waste Authorisation

wind power projects use different types of fluids for the smooth operation of the WTG. Primarily, three main types of fluid are used: (a)Generator cooling fluid is used as coolant (a mixture of glycol and water, similar to what is used in automobile radiators) (b)Lubricating oil is used in the gearbox (synthetic oil) (c)Hydraulic oil for operating the blade pitch system, yaw mechanism and brakes. To protect transformer from heating, mineral oil (transformer oil) is used as coolant.
[According to Section 3 (ze) of the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008:]

2. Permission from Forest Department

Under Rule 6 of the Forest (Conservation) Rules, 2003, any project that intends to use forest land for non-forest purposes must submit a proposal using the prescribed forms included in the rules.

	Advising/ Recommending body	Route	Final clearance authority
< 1 hectare	–	–	State government (Principal Secretary of Forests)
1–5 hectare	State forest department	State government to regional office of MoEF	Regional office MoEF
5–40 hectare	State Advisory Group	State government to regional office of the MoEF; then to the MoEF with State Advisory Group recommendations	MoEF
> 40 hectare	Forest Advisory Committee	State government to MoEF	MoEF

Forest clearance procedure, Source:- Forest (Conservation) Rules, 2003

The forest clearance process begins with the project proponent submitting an application to the nodal officer of the state forest department. The application is forwarded to the district-level field office, where an inspection of the proposed land is conducted. After this evaluation, the application is sent back through the forest department hierarchy to the Principal Secretary of Forests. The final approval authority depends on the extent of forest land to be diverted: the proposal may either be approved by the Regional Office of the Ministry of Environment, Forest, and Climate Change (MoEFCC) or by the Secretary, at the regional or central level, based on the project's scale and requirements. [Rule 6 of the Forest (Conservation) Rules, 2003].

Further, the forest guidelines also specify certain criteria for the setting-up of a development project, which states that no projects should be in the vicinity of the following:

- National Parks, Wildlife Sanctuaries and Core areas of the Biosphere Reserves.
- Scenic landscapes, areas of geo-morphological significance, unique and representative biomes and eco-systems, heritage sites/structures and areas of cultural heritage and importance.
- Fragile eco-systems such as mountains; areas rich in coral formations as well as marine, coastal, desert, wetland, riverine and island eco-systems. Areas rich in biological diversity, gene pool and other natural resources.

3. Eco-sensitive zones

In 2002, the MoEF decreed that an area of 10 km around national parks and sanctuaries should be assigned as an eco-sensitive zone, with restrictions on development.

Any project including wind power projects that fall inside the zone have to seek approval from the National Board for Wildlife (NBWL). The NBWL may conduct a study if it believes the project may have large-scale impact.

Wildlife Board's guidelines on linear intrusion

The guidelines are extensive and focus firstly on how to avoid the need for new roads and powerlines in natural areas. Only after avoidance is ruled out, do the guidelines go into details of how roads and powerlines should be built to minimise and mitigate damage.

- Keep construction phase as short as possible, avoid night-time work as it disturbs animals.
- When one linear intrusion has been made, new projects should align with it so as not to cause further destruction
- According to the guidelines, roads should be no wider than 12.5 m for primary roads and 8.5 m for secondary roads.

- To avoid electrocution of elephants powerlines should be a minimum of 6.6 m above ground on level terrain and a minimum of 9.1 m above ground on steeper terrain.
- Maintaining 1.5 m spacing between energized components, cover and insulate energised hardware, include reflectors and perch deterrants. Install underground cables. Monitor effectiveness of measures.
- Structures, such as retaining walls that can act as barriers to animal movement should not be installed along roads, especially in hilly terrain.

[National Board for Wildlife - Guidelines for linear infrastructure intrusions in natural areas: roads and powerlines]

4. NOC from Airports Authority of India (AAI) and Ministry of Defence

Aircraft Act, 1934 empowers the Central Government to impose restriction on the construction of buildings and other structures within a radius of 20 Km from ARP of all aerodromes.
No Wind Turbine Generators (WTGs) shall be installed up to 10 Km from the Radar Antenna of all Static Air Defence Radars and up to 8 km from ATS Radar antenna/VOR.

Colour Coded Zoning Maps (CCZMs)

CCZMs have been formulated for all IAF aerodromes and handed over to Local Municipal Authorities (LMAs). Area in the centre of CCZM of 4 Km radius around threshold of an IAF aerodrome is marked in Red. For all proposed constructions falling in Red Grid/Zone, it shall be mandatory for an applicant, to submit application in specified format and obtain NOC from IAF as per existing procedures/guidelines.

Area beyond 4 Km from threshold has been demarcated in various zones with different Colour Codings on the CCZM. Local Municipal Authorities (LMAs) can approve any building/infrastructure plans only up to maximum elevation specified in the respective zones as depicted on CCZM without referring the case to IAF.

Under GSR 751 (E), the area marked in ‘Green’ is beyond 20 Km from Aerodrome Reference Point of an IAF airfield and is outside the purview for issuance of NOC by IAF. Hence, for any construction/proposal in areas marked in ‘Green’, the applications are not required to be processed for infrastructure up to a max height of 150 m AGL above aerodrome elevation.
[GUIDELINES FOR ISSUE OF NOC FOR CONSTRUCTIONS AROUND INDIAN AIR FORCE AERODROMES]

5. No Objection Certificate (NOC) from State Electricity Board

6. Land Allotment Letter

7. NOC from the District Level Industrial and Revenue (DLIR) Department

8. NOC from Mining Department

9. NOC from Village Panchayat

10. Power Purchase Agreement (PPA)

5.3 Land Leasing

Policy 2023 aims to facilitate the leasing of government fallow land in Gujarat for the establishment of green hydrogen production facilities. These facilities will utilize non-conventional renewable energy sources such as solar, wind, and hybrid wind-solar energy. [8]

5.3.1 Lease Duration and Terms

Lease Period: 40 years.

Annual Rent: ₹15,000 (€ 150 – €170) per $[10^4\ m^2]$ area, subject to a 15% increase every three years.

Advance Payment: Annual rent and applicable taxes must be paid in advance. Late payments integrate 12% simple interest after 90 days.

Security Deposit: Applicants must provide a deposit equivalent to one year's rent, a 1% service charge, and necessary stamp duty upon land possession. [8]

5.3.2 Eligibility and Allocation

Criteria: Includes financial stability (minimum net worth of ₹1200 crore (€130.44 million)), experience in renewable energy generation (minimum 500 MW).

Land Allocation Limits: One applicant or their partners can only lease enough land to produce 30 lakh metric tonnes ($3\ x\ 10^8$) of green hydrogen each year. This means they can't lease more land than what is necessary for that amount of production. [8]

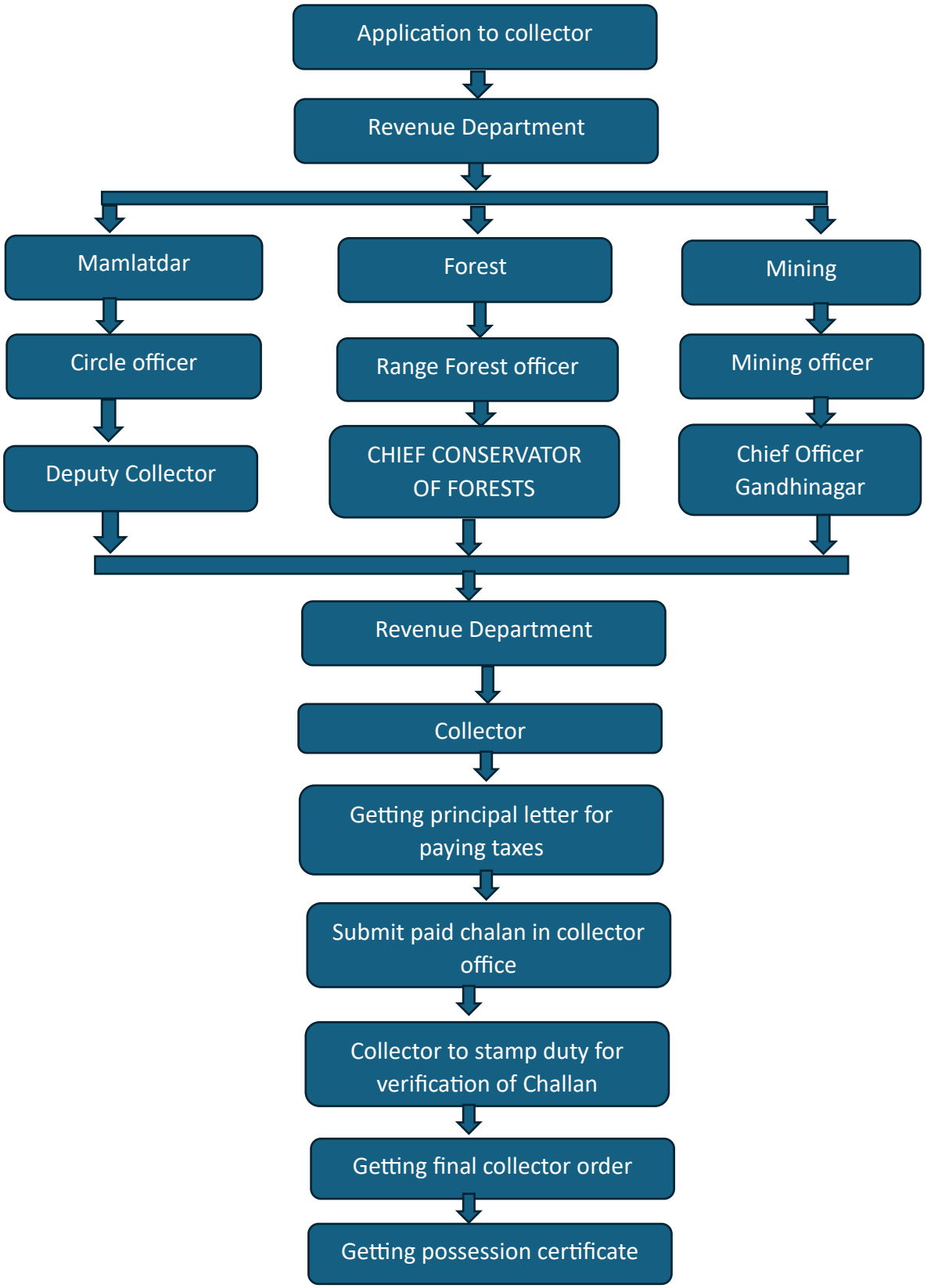
5.3.3 Application and Approval Process

Pre-Feasibility Report: Applicants must submit a preliminary report demonstrating their capability to produce green hydrogen.

Review Committees: A Committee of Experts evaluates the applications, followed by the High-Power Committee for final recommendations. [8]

Tripartite Agreement: Upon approval, a tripartite agreement is signed between the Collector, the nodal agency (GPCL), and the applicant. [8]

Government land Approval Process



[Government land approval process for wind farm, Source :- Revenue Department, Gujarat https://www.adb.org/sites/default/files/project-documents/51210/51210-001-iee-en.pdf]

Private land Approval Process

Step 1: Title Clearance

The first step involves ensuring that the title of the land is clear. This includes:

- Checking all historical ownership records.
- Ensuring there are no disputes, encumbrances, or legal issues associated with the land.
- Reviewing registered documents with the Sub-Registrar's office.

Step 2: Agreement to Sell (ATS) and Sale Deed

- **Agreement to Sell (ATS)**:
    - The developer enters into a formal agreement with the landowner, documenting the agreed price, terms of payment, and timelines for the transaction.
    - The ATS may involve an advance payment.
- **Sale Deed**:
    - Once the terms in the ATS are fulfilled, a sale deed is executed.
    - The sale deed is then registered with the Sub-Registrar’s office, completing the legal transfer of ownership to the developer.

Step 3: Application and Obtaining 89A Permission from revenue department

- **Purpose of 89A Permission**:
    - Under Section 89A of the Gujarat Land Revenue Code, this permission is required to formally register the land transaction.

Step 4: Conversion to Old Tenure Land & Payment of Premium

- **Understanding Land Tenure**:
    - Land in Gujarat is often classified as "new tenure" (with restrictions on sale or use). Developers must convert it to "old tenure" to remove restrictions.

Step 5: Apply and Obtain 65 Kh Permission (Non-Agricultural or NA Use)

- **Purpose of 65 Kh Permission**:
    - Land classified as agricultural must be converted to non-agricultural (NA) for setting up infrastructure like wind turbines.
- **Application Process**:

- The developer applies to the District Collector or Revenue Department with relevant documents (title clearance, sale deed, and tenure conversion approval).
- The Collector grants permission, officially converting the land use to NA, allowing construction to proceed.

[Private land approval process for wind farm, Source :- Revenue Department, Gujarat https://www.adb.org/sites/default/files/project-documents/51210/51210-001-iee-en.pdf]

5.3.4 Usage and Compliance

Dedicated Use: Leased land must be exclusively used for green hydrogen production.

Development Timeline: Projects must develop infrastructure and achieve 50% capacity within 3 years and full capacity within 8 years.

No Subleasing: The leased land cannot be subleased to third parties. [8]

5.3.5 Financial and Operational Responsibilities

Infrastructure Development: Applicants are responsible for all infrastructure, including power transmission, roads, water supply, and security.

Energy Usage: Generated renewable energy must primarily be used for green hydrogen production within Gujarat. Excess energy sales are subject to government discretion.

Charges and Taxes: All applicable taxes, licensing fees, and GST must be borne by the lease agreement. [8]

Governance and Oversight

Provision of Land procurement/ acquisition in Gujarat Wind Power Policy 2016

The Gujarat Energy Development Agency (GEDA) will act as the State Government's Nodal Agency for implementing and facilitating the Gujarat Wind Power Policy-2016. GEDA will support project developers by assisting with the following activities to achieve the policy's objectives:

- **Project Registration**: Ensuring wind power projects are properly registered.
- **Developer Assistance**: Addressing queries and resolving issues faced by wind power project developers.
- **Accreditation**: Facilitating the accreditation and recommending wind power projects for registration with the Central Agency under the Renewable Energy Certificate (REC) mechanism.

Wind Turbine Generators (WTGs) can be established on private land, revenue wasteland allotted by the State Government, or land owned by GEDA (if available). The allocation of GEDA-owned land on lease requires the approval of a Coordination Committee, as detailed in the policy's framework. Additionally, this committee is responsible for resolving issues beyond land allotment, such as interpreting specific provisions of the policy.

S.No	Department	Designation
1	ACS/PS/Secretary (CCD)	Chairman
2	AS/JS/Deputy Secretory (EPD)	Member
3	Chief Electrical Inspector & Collector of Elect. Duty	Member
4	General Manager (Comm), GUVNL	Member
5	Respective District Collector	Member
6	Director, GEDA	Member Secretary

(Source: https://geda.gujarat.gov.in/policy_files/Gujarat%20Wind%20Power%20Policy-2016.pdf)

5.4 Informal Permission of Community

Community Meetings: Organize meetings with community members to explain the benefits of the project, such as job creation, infrastructure development, and clean energy. Address any concerns and answer questions.

Engage Local Leaders: Work with local leaders and influential community members to gain their support. Their endorsement can help in building trust and acceptance within the community.

Transparency: Maintain transparency throughout the process by sharing project details, timelines, and potential impacts. This can help in building trust and reducing resistance.

Benefit Sharing: Propose benefit-sharing, such as community development funds, scholarships, or infrastructure improvements, to ensure that the community also gains from the project.

Regular Updates: Keep the community informed about the progress of the project through regular updates and open communication channels.

- Processing

6.1 Commissioning all necessary studies

6.1.1 Environmental Impact Assessment (EIA)

While wind energy is a greener choice compared to fossil fuels, it has some environmental challenges. One major issue is that birds, especially predators like raptors, can accidentally fly into the spinning turbine blades, leading to injuries or deaths. These impacts interrupt local ecosystems, as seen in reduced raptor populations leading to increased numbers of prey species, such as the fan-throated lizard. Noise from turbines and habitat disruption during construction can further affect wildlife. [9]

In India, even though environmental impact assessments (EIA) are not required for wind farms, the wind energy sector still must follow certain guidelines from the Ministry of Environment and Forests (MoEF). If a wind power project is located in a forest, national park, or wildlife sanctuary, it must get approval from the State Forest Board, the State Pollution Board, and the National Board for Wildlife. Additionally, if the land is home to scheduled tribal communities or traditional forest residents, the project must comply with the Scheduled Tribes and Other Forest Dwellers Act, 2006.6.1.2 Geophysical and Geo-Technical Studies. [9]

6.1.2 Social Impact Assessment (SIA)

Impact on Livelihoods: Assess how the project might affect local livelihoods, such as agriculture and fishing, while identifying potential benefits like job creation and infrastructure improvements.

Health and Safety: Evaluate possible health and safety impacts, including noise pollution and environmental changes that could affect the community.

Cultural and Heritage Impact: Examine the impact on cultural heritage sites, traditional practices, and local customs to ensure the project does not harm these aspects.

Economic Impact: Analyse economic benefits and costs to the local community, such as changes in property values and opportunities for local businesses. [10]

6.1.3 Wildlife and Habitat Studies

6.1.4 Regulatory Compliance

Ensure that the project complies with all relevant local, state, and national regulations and standards. [11]

6.2 Wind Measurement

6.3 Grid Connection

6.4 Profitability and Financing

6.5 Wind Area

• Post-processing

7.1 Permit Approval Process

7.2 Financial Support, Finding Investors and Find O&M company

7.3 Apply for Auction

7.4 Construction

7.5 Commissioning

7.6 Official Opening

• Schedule and Timetable

• Conclusion

Summary of Key Points, Final Recommendations, Future Outlook

a. What is the decarbonisation plan of your country (2030/2050) and which role does wind energy play?

b. What are the most important barriers and obstacles for the development of wind farms?

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- ## Appendices

Technical Data Sheets

Maps and Diagrams

Stakeholder Consultation Records

Additional Supporting Documents

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