Oando Clean Energy

National Wind Resource Capacity Report

Nigeria | **2025**

Obudu, Cross River State

National Wind Resource Capacity Report

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Oando Clean Energy Limited (OCEL)

Headquartered in Lagos Nigeria, OCEL is the renewable energy business subsidiary of Oando Energy Resources, a part of the Oando PLC group of companies.

Our agenda is to invest in climate friendly and bankable energy solutions across the African continent; meeting our demand through the exploitation of green and renewable sources.

With roots dating back to 1956, we have been in the energy value chain with a track record of operation excellence and investments in projects that proffer solutions to some of Africa's energy challenges.

Against this backdrop, as well as increasing pressure for the world to transition to cleaner fuels, we have expanded our portfolio from Oil and Gas to include non-fossil energy solutions.

This a natural trajectory in our journey to create impact that will outlive us.

OCEL is driving Nigeria's clean energy transition in line with the country's Energy Transition Plan and Net Zero 2060 goals. The company is developing solar panel assembly and PET material recycling plants, promoting the adoption of electric vehicles for mass transportation and taxi hailing services with charging infrastructure across the country, and exploring wind energy to expand Nigeria's renewable energy capacity.

Additionally, OCEL is at the forefront of harnessing geothermal power in Nigeria by repurposing end-of-life oil wells to decarbonize oil and gas production in the Niger-Delta.

With a focus on project bankability, OCEL ensures financial viability, technical feasibility, and regulatory compliance in all its initiatives. In all these, OCEL is leading Nigeria's clean energy transformation, fostering sustainability, economic resilience, and environmental stewardship.

Climate Friendly and Bankable Energy Solutions for Africa

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Wind Energy in Nigeria

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Executive Summary

To build Africa's largest integrated green energy company

Wind energy is a cornerstone...

of the global transition to renewable energy, with over 1 terawatts (TW) of installed capacity as of 2023 and expected to rise to 2.8TW by 2035. The sector has achieved significant milestones, including record-breaking installations of 117GW in 2023 and projections of 158GW in annual installations by 2028.

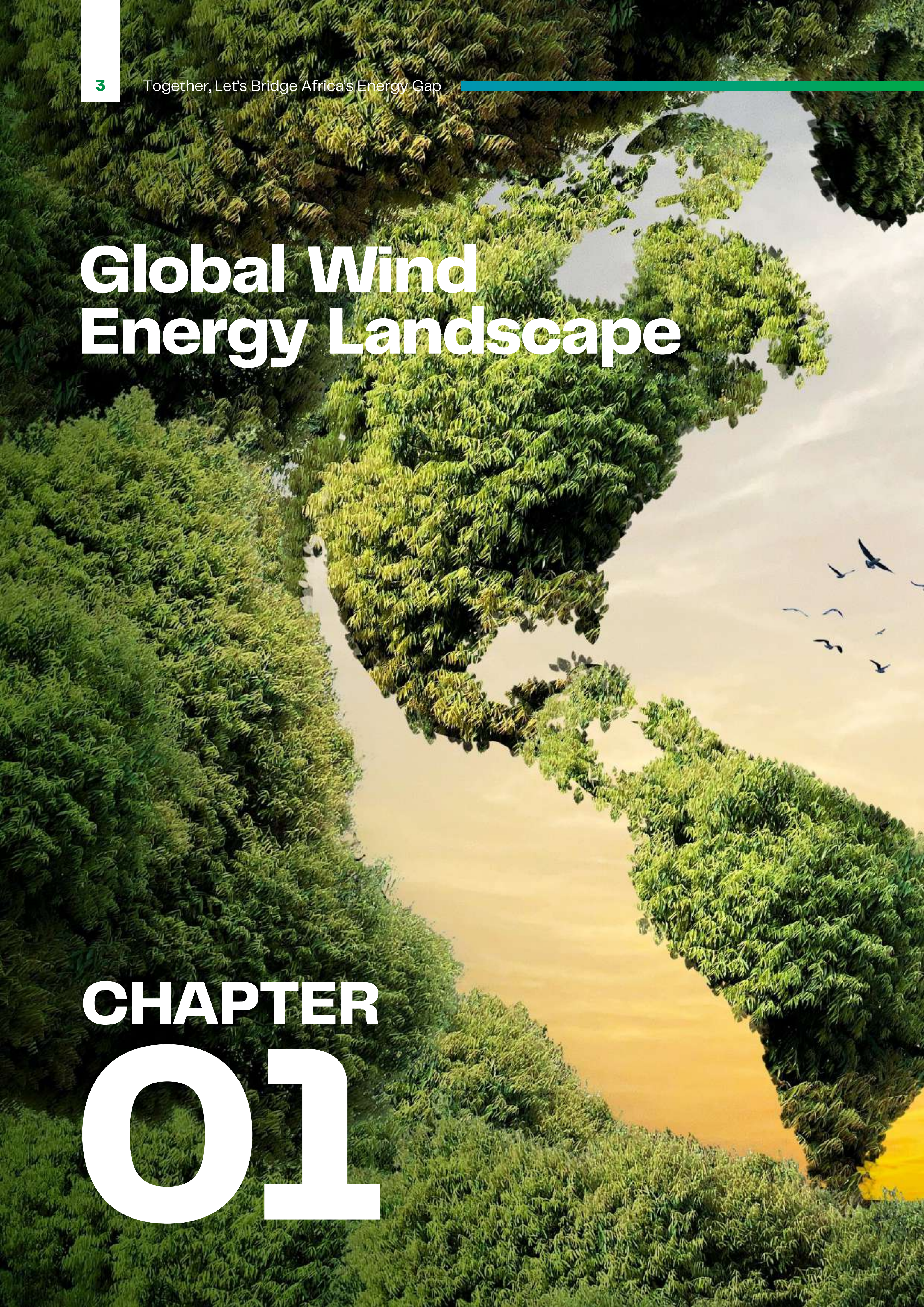
Key players in the wind turbine manufacturing industry, such as Vestas Wind Systems A/S, Siemens Gamesa Renewable Energy S.A., and GE Renewable Energy, drive innovation and capacity growth, with the top 10 manufacturers accounting for a cumulative active capacity of 551GW globally.

Leading wind energy companies like NextEra Energy, Iberdrola, Enel SpA, and Adani Green Energy demonstrate a strong commitment to expanding wind infrastructure worldwide. Europe remains a hub for wind energy with 272GW of installed capacity, while the Asia-Pacific region, led by China (440GW) and India (44GW) continues to lead the wind energy market with 519.6GW of total installed capacity. China remains the global leader in new wind energy installations adding about 75GW of wind capacity in 2023 (66% of 2023's global wind installations) a huge disparity when compared to Africa's and Middle East's 1.16GW of new wind capacity in 2023.

While wind energy development continues to improve globally especially in the developed economies, developing nations continue to lag far behind with the African and Middle East region boasting just around 11GW of total installed wind capacity.

Drivers of this growth include supportive policies, technological advancements (Offshore Wind Development), and increased focus from global leaders (China, United States). Challenges such as supply chain constraints, land acquisition hurdles, and regulatory complexities persist but are being addressed through collaborative global efforts. The future outlook remains optimistic, with wind energy poised to become the second-largest renewable electricity source globally by 2035, trailing only solar energy.

China remains the global leader in new wind energy installations adding about 75GW of wind capacity in 2023 (66% of 2023's global wind installations) a huge disparity when compared to Africa's and Middle East's 1.16GW of new wind capacity in 2023.



Global Wind Energy Landscape

CHAPTER 01

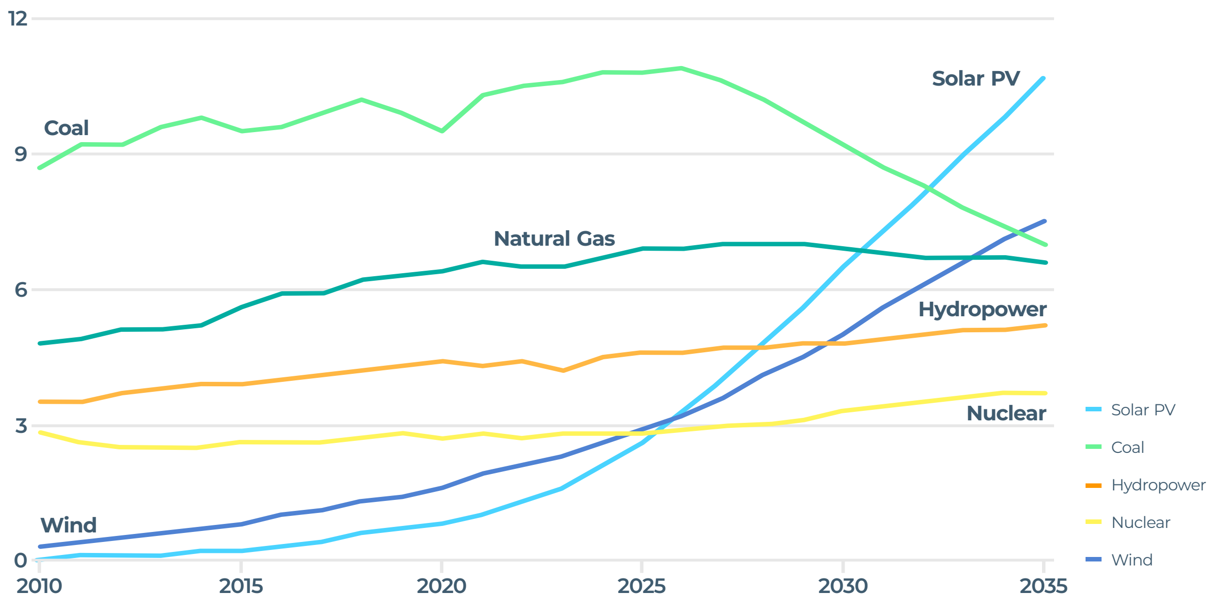
Overview

At COP28, nearly 200 nations reached a consensus on the urgent need to triple global renewable energy capacity and double improvements in energy efficiency by 2030, aligning with pathways to limit global warming to 1.5°C. Wind energy, which has become increasingly cost-effective and available, was recognised as a key climate change mitigation technology, and continues to expand as a cornerstone of the global transition to renewable energy, with advancements in both onshore and offshore wind technologies driving progress toward ambitious climate goals.

As of 2024, over 60 countries have incorporated wind deployment targets into their climate commitments, underscoring its strategic importance. According to the International Energy Agency (IEA), wind energy is projected to become the second-largest renewable source of electricity worldwide by 2035, trailing only solar energy. Installed wind capacity is expected to surpass 2,800GW by that time, reflecting its rapidly growing contribution to the global energy mix.

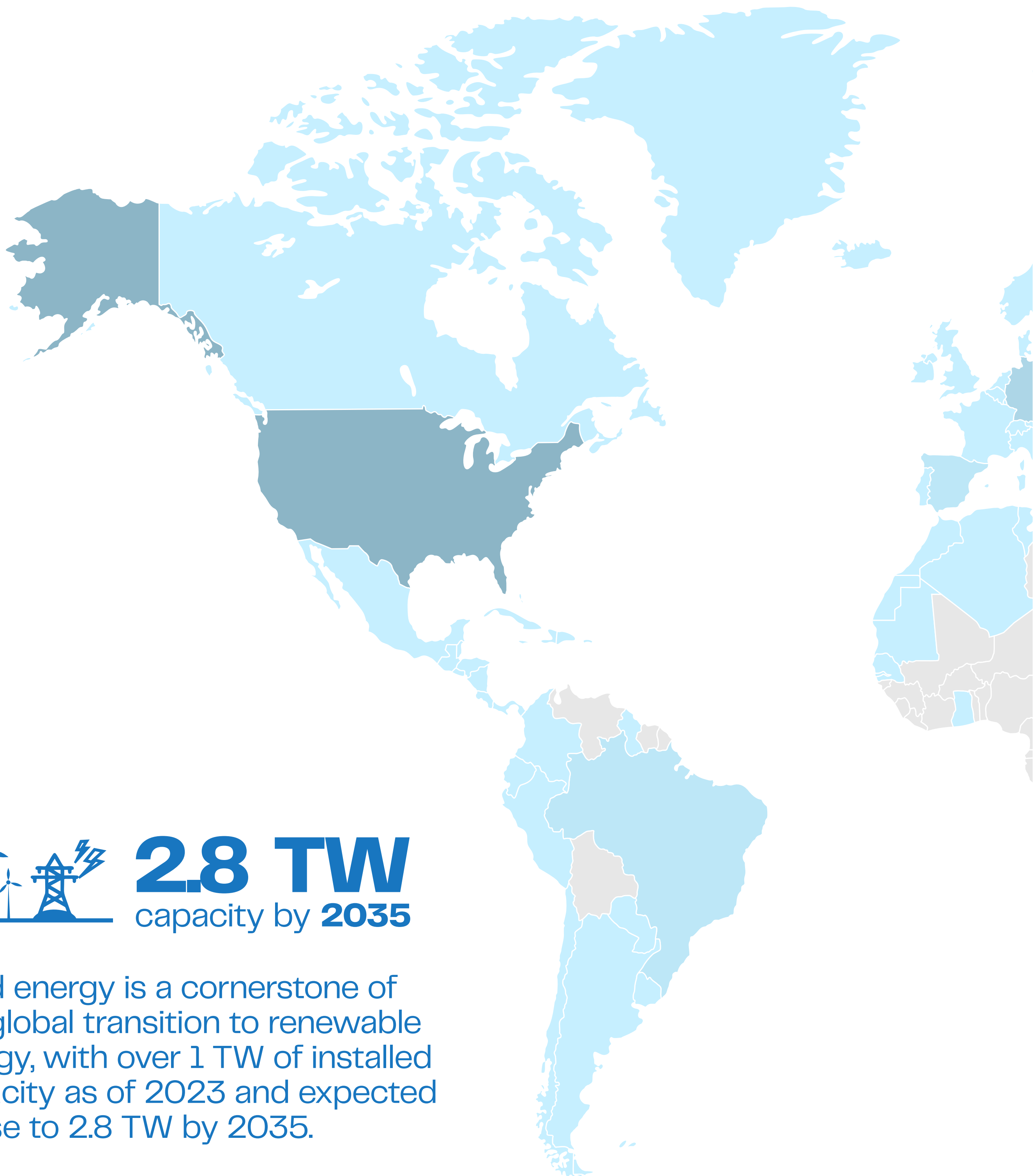
(Global Wind Energy Council, World Energy Outlook 2024 – Analysis - IEA).

World Electricity Generation in the Stated Policies Scenario, 2010-2035



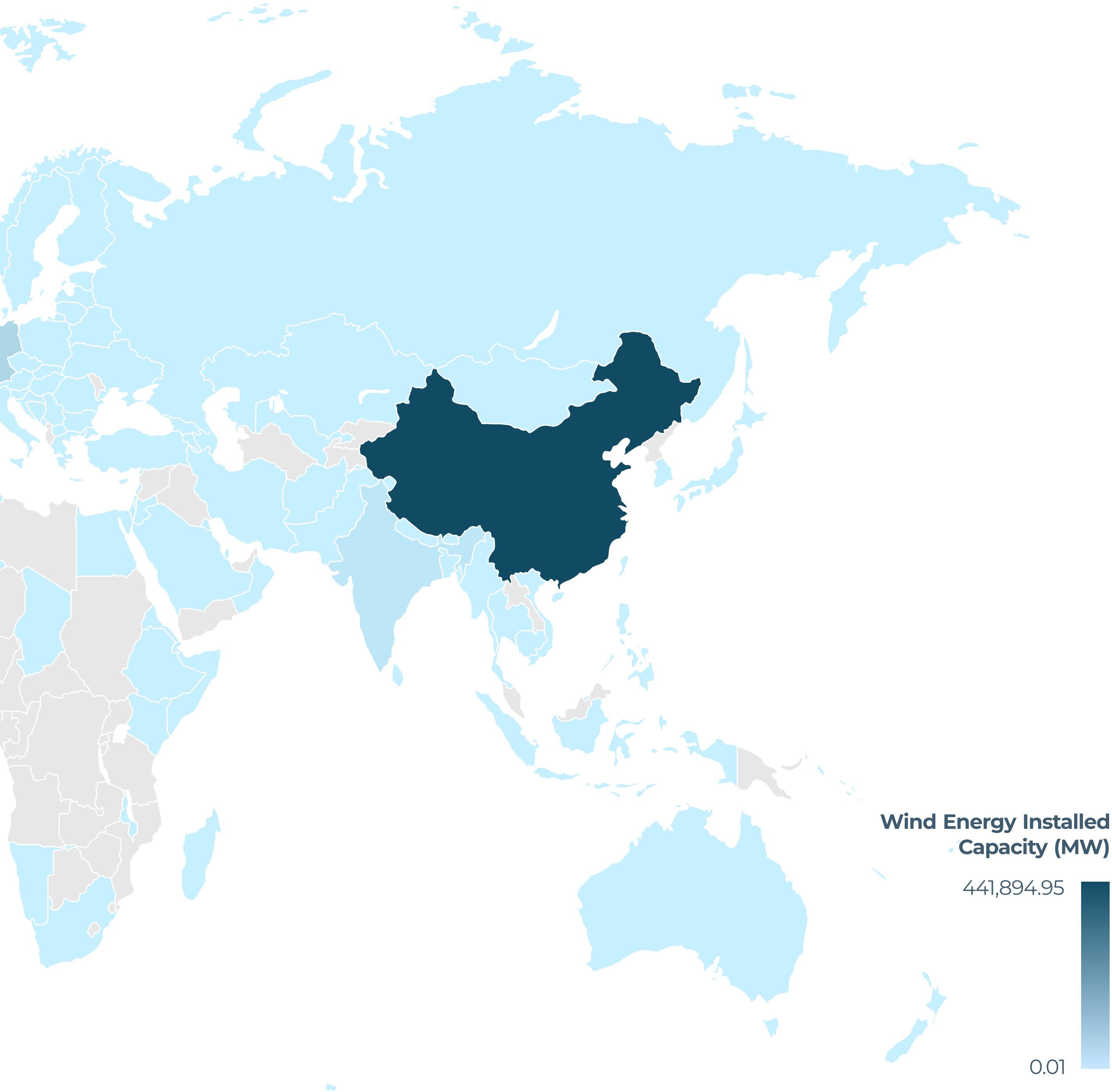
Source: IEA, (2024) World electricity generation in the Stated Policies Scenario, 2010-2035 – Charts – Data & Statistics

Global Footprint of Wind Farms by Installed Capacity



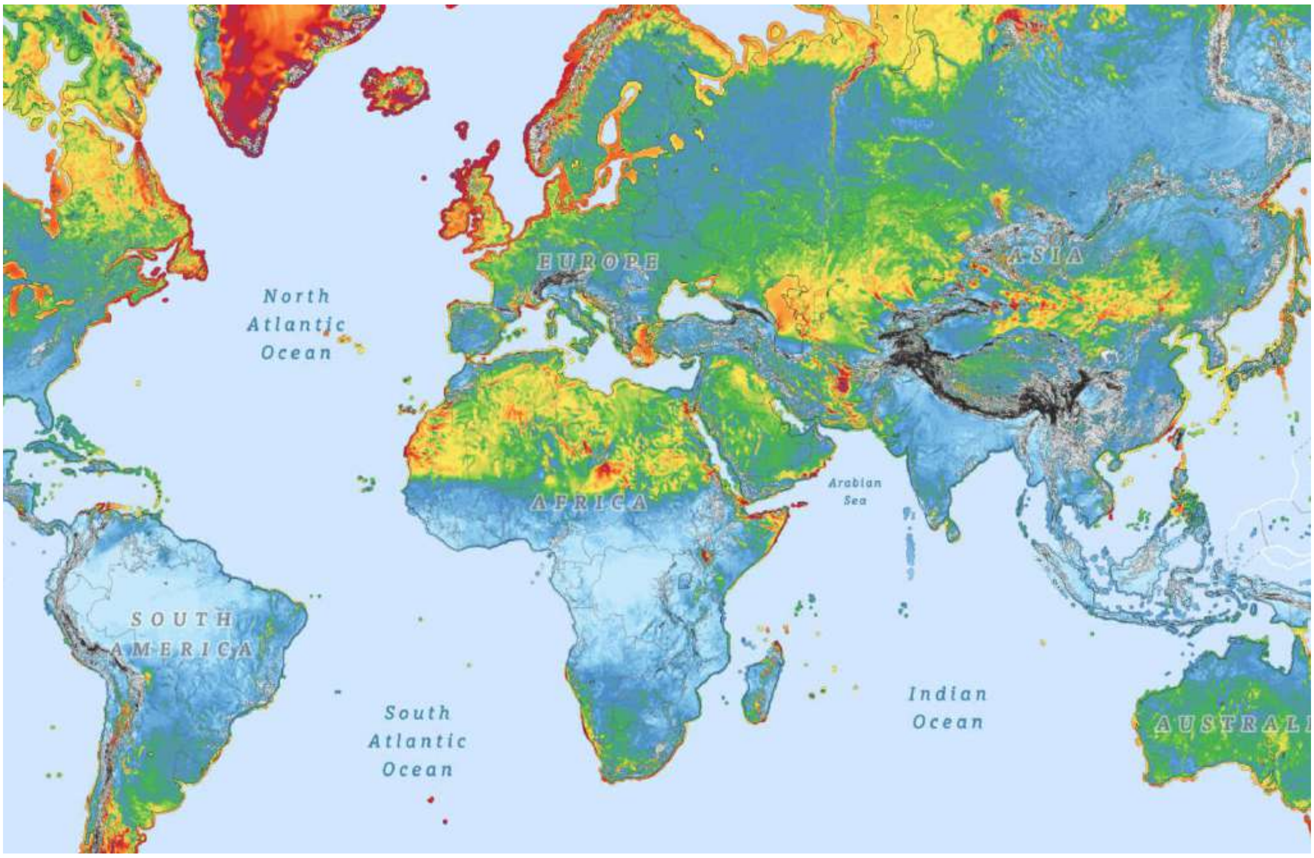
2.8 TW
capacity by **2035**

Wind energy is a cornerstone of the global transition to renewable energy, with over 1 TW of installed capacity as of 2023 and expected to rise to 2.8 TW by 2035.



Source: IRENA (2023). Country Rankings | **Largest Wind Power Farms Worldwide by Installed Capacity**

Geographical Highlights

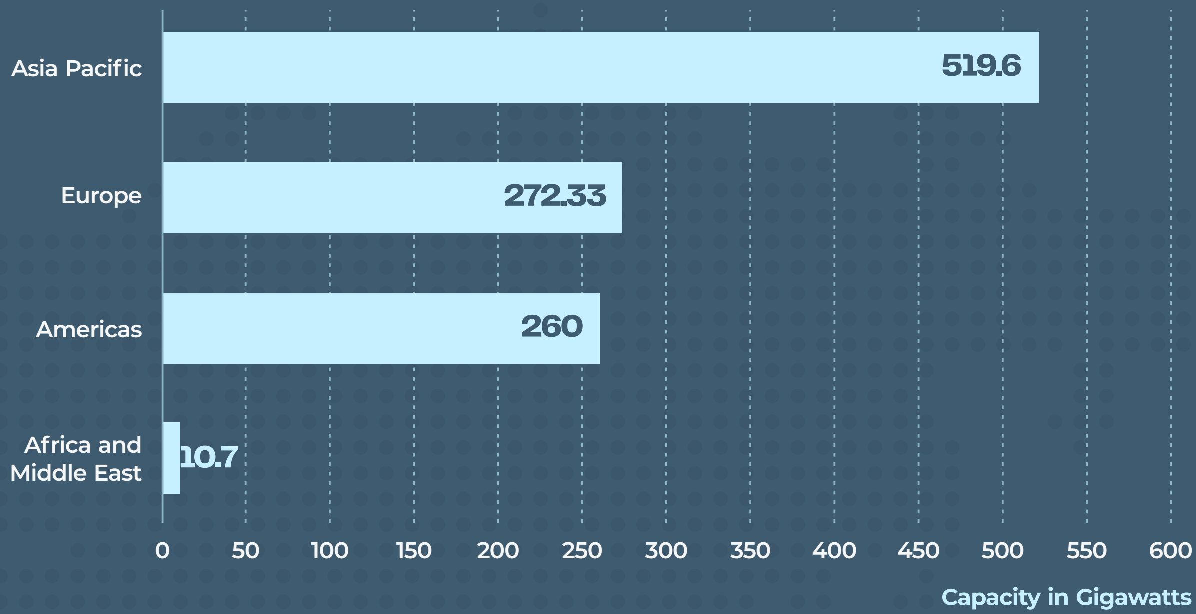


The Asia-Pacific region remains the global leader in wind energy, with a total installed capacity of 519.6GW, primarily driven by China (~440GW) and India (~44GW). Europe follows behind with around 272GW of wind power capacity with leading contributions from Germany (69GW), Spain (30GW), and the UK (29GW) (WindEurope, 2023).

In 2023, the global wind energy sector achieved a record-breaking milestone with 117GW of new capacity installed, including 106GW of onshore and 10.8GW of offshore wind. This represents a 50% increase compared to 2022 and brings total installed wind power capacity worldwide to over 1 terawatt (TW), marking significant progress in global decarbonization efforts. New wind capacity for the subsequent years is expected to surpass this achievement.

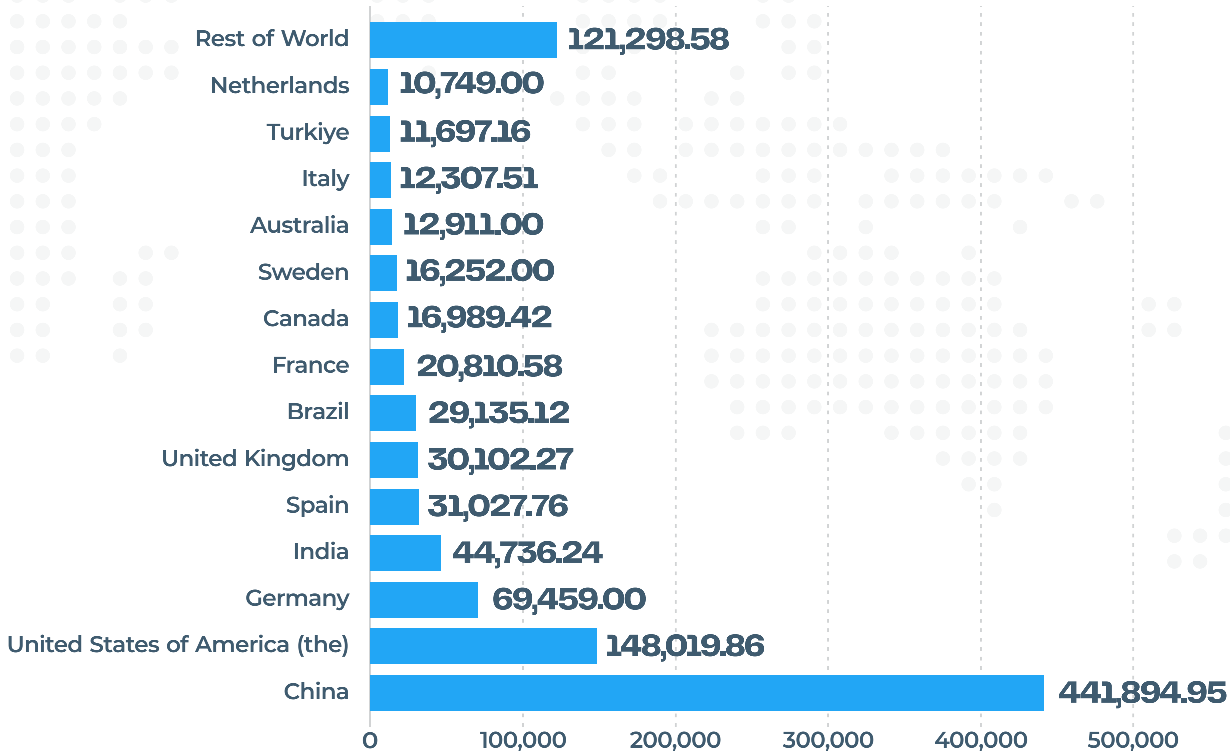
North America led by the United States possesses around 150GW of installed capacity. While wind energy development continues to improve globally especially in the developed economies, developing nations continue to lag far behind with the African and Middle East region boasting just around 11GW of installed wind energy.

Global Installed Wind Power Capacity in 2023, by region (in gigawatts)



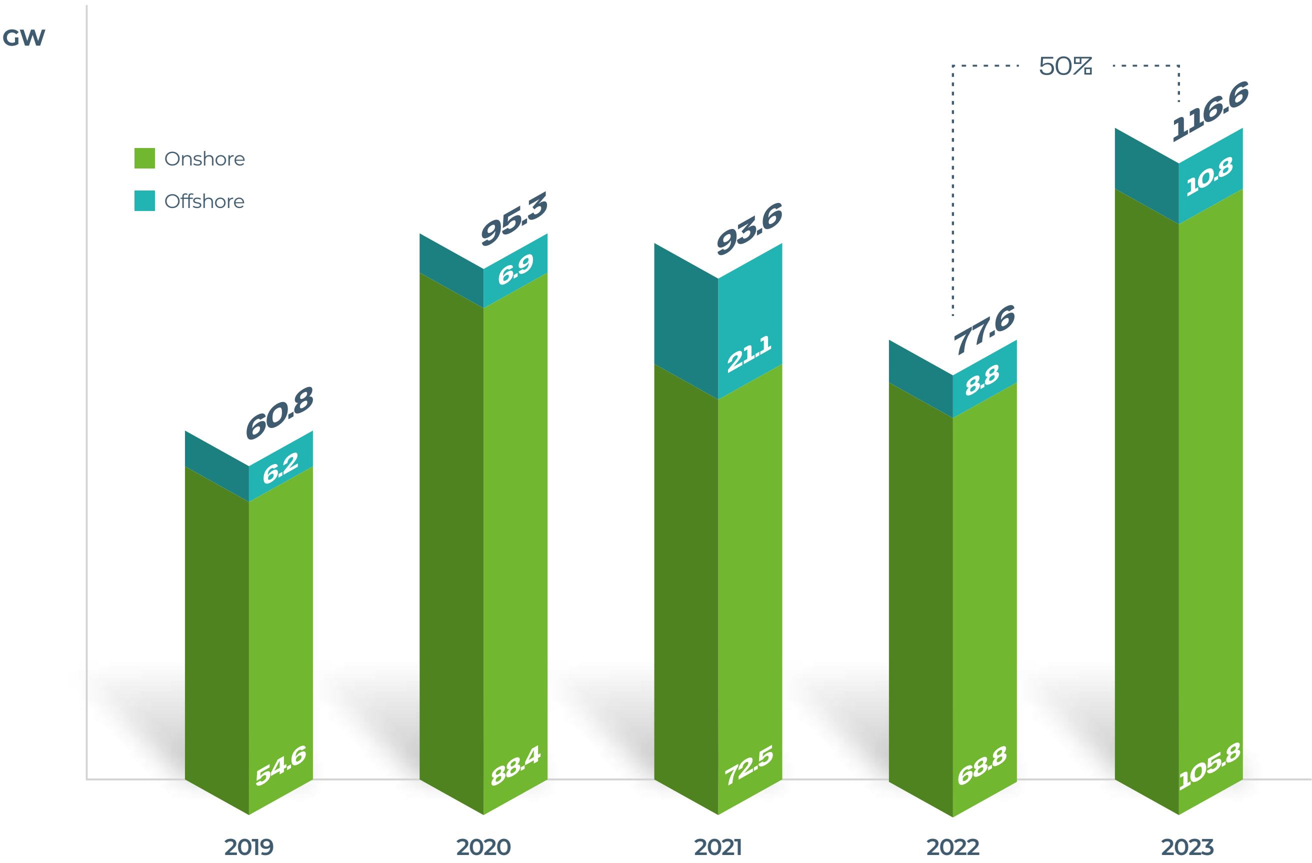
Source: Statista, GWEC (2023) | **Global installed wind power capacity by region 2023**

Top Countries with Electricity Installed Capacity (MW) via Wind Energy

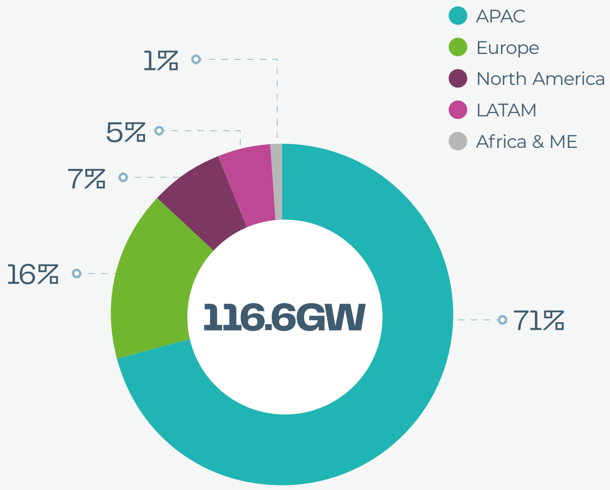


Source: Irena (2023) Country Rankings

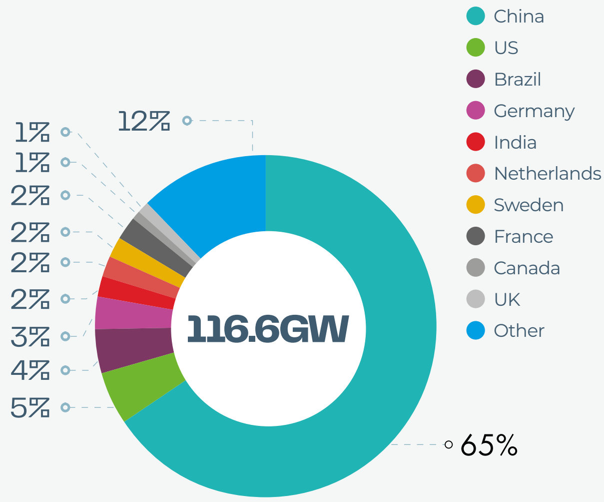
New Installations



New Capacity in 2023 Installed by Region (%)



New Capacity 2023 and Share of Top Five Markets (%)



Source: Global Wind Energy Council (2024)

In terms of new wind installation, China remains the global leader in wind energy installations adding about 75GW of wind capacity in 2023 (66% of 2023's global wind installations), driven mostly by its robust domestic policies and large-scale offshore wind developments. Countries like the Netherlands (34%), Finland (22%), Brazil (20.8%), Vietnam (24%) and Chile (26%) all had growth rates well above the global average and are now amongst the most dynamic markets.

Expansions in other advanced economies was much lower, with only 18GW of new wind capacity additions in the European Union with previous leaders - Germany, Spain and the UK underperforming with wind capacity growth rates remaining well below 10%. The United States had lower wind capacity additions with just above 6GW of new installations taking its total capacity past 150 Gigawatts. However, capacity additions in the United States and the European Union are projected to increase significantly in the coming years in part reflecting the long-term policy support provided by the US Inflation Reduction Act and to recent European Union policies to address the challenges posed by slow permitting procedures and enhancing energy security.

When looking at Africa, the continent as a whole showed little momentum in terms of new capacity for 2023. Only Morocco, the third largest market, showed significant growth, adding 616MW to bring its total capacity to just over 2 Gigawatt. Egypt added 183MW and now has 1.9GW. Issues such as the cost of financing and revenue uncertainty continue to constrain rapid development in these emerging and developing economies. However, many African countries are focusing on rural electrification, where wind turbines can be used alongside solar technologies for decentralized powering.

Top Wind Turbine Manufacturers

The global wind turbine manufacturing industry is dominated by key players that contribute significantly to the growth of wind energy worldwide. As of April, 2024, the top five wind turbine manufacturers by installed capacity were Vestas Wind Systems A/S, Siemens Gamesa Renewable Energy S.A., GE Renewable Energy, Enercon GmbH, and Nordex SE.

Collectively, the top 10 manufacturers accounted for a total active capacity of 551,207MW, with Vestas Wind Systems leading at 150,580MW, followed by Siemens Gamesa at 120,131MW, and GE Renewable Energy at 108,201MW.

Leading Wind Turbine Manufacturers

Vestas Wind Systems A/S

Siemens Gamesa Renewable Energy S.A

GE Renewable Energy

Enercon GmbH

Nordex SE

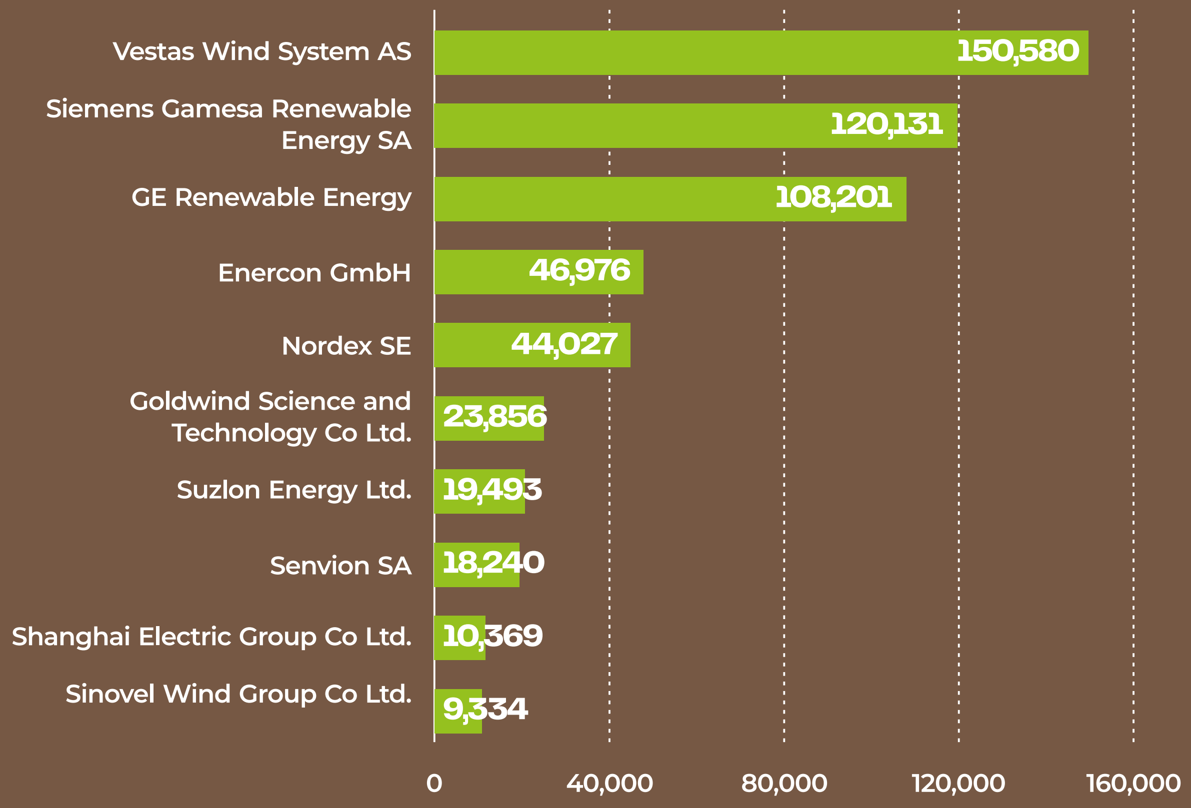
#1 Vestas Wind Systems

150,580MW

#10 Sinovel Wind Group Corporation

9,334MW

Top 10 Wind Turbine Manufacturers in the World by Capacity (MW)



Source: GlobalData (2024) Top Global Wind Turbine Manufacturers by Capacity | **Renewable Energy Leaders**

Leading Banks/Financiers in Wind Energy

European Investment Bank

The European Investment Bank (EIB) is a key player in the global advancement of renewable energy.

Through innovative financing, it has supported sustainable power generation and clean energy transitions in the Middle East by funding important wind projects such as Morocco's offshore projects and Jordan's Tafila Wind Farm.

https://www.eib.org/en/index

AIIB ASIAN INFRASTRUCTURE INVESTMENT BANK

The AIIB, with a focus on renewable energy, is dedicated to funding sustainable infrastructure throughout Asia and beyond.

It has supported projects in Uzbekistan and provided vital loans for wind projects such as Kazakhstan's Zhanatas and Shokpar Wind Farms, encouraging the regional expansion of renewable energy and reducing dependence on fossil fuels.

https://www.aiib.org/en/index.html

MUFG

MUFG Bank, one of the largest international banking groups, plays a crucial role in funding clean energy initiatives worldwide. By offering structured debt, tax equity, and creative financing options, it accelerates the deployment of renewable energy.

MUFG has supported key wind projects, including Mexico's 130MW La Bufa Wind Farm and Texas' 197MW Castle Gap.

https://www.bk.mufg.jp/global/index.html

BANQUE AFRICAINE DE DEVELOPPEMENT · AFRICAN DEVELOPMENT BANK · AFRICAN DEVELOPMENT FUND · FONDS AFRICAIN DE DEVELOPPEMENT

The AfDB is committed to accelerating Africa's energy transition by financing transformative renewable energy projects.

It has supported large-scale wind initiatives such as Egypt's 1.1GW Suez Wind Farm and Morocco's integrated wind -hydro programs, providing significant loans and technical assistance to enhance clean energy infrastructure across the continent.

https://www.afdb.org/en

JPMorganChase

JPMorgan Chase is a leading financier of wind energy projects, committing $200 billion toward clean energy financing by 2025. The bank has supported numerous wind farms through tax-equity investments and project financing.

Notably, it helped finance the Clearway Energy Group's Mesquite Star Wind Farm in Texas, a 419MW project that supplies clean energy to corporate and municipal customers.

https://www.jpmorganchase.com/

standard chartered

citi

Triodos Bank

European Bank for Reconstruction and Development

KDB Bank

NATIXIS BEYOND BANKING

Notable Consulting Firms in Wind Energy

Black & Veatch, an international engineering firm with decades of experience, has completed high-profile projects such as Vineyard Wind and Cardinal Point.

They offer a comprehensive range of services, including engineering, procurement, construction, and consulting. The firm is at the forefront of offshore developments and floating wind technology.

https://www.bv.com/

OWC, dedicated exclusively to wind energy, brings extensive experience to more than 330 offshore projects and advises on 71GW of onshore capacity.

They play a crucial role in the global transition to renewable energy by providing technical due diligence, project management, and market insights.

https://owcltd.com/

SgurrEnergy, a wind-specialist consultancy with over 100GW of project experience, has worked on notable projects like Galloper Offshore, Beatrice, and Latigo Wind Farms. Their technical advisory, due diligence, and optimization services drive advancements in both onshore and offshore wind energy industries.

https://www.sgurrenergy.com/

Fichtner, a globally recognized engineering and consulting firm with decades of experience in wind energy, has contributed to projects such as Magolsheim onshore, Gunfleet Sands offshore, and various wind farms in Vietnam. Their comprehensive services, spanning from feasibility studies to commissioning, significantly advance wind energy development.

https://www.fichtner.de/en/

DNV·GL

Now operating as DNV, this leader in certification and technical due diligence has decades of experience in the field. They set international benchmarks for offshore wind energy sustainability, performance, and safety through initiatives like WindFloat Atlantic and Meerwind Süd|Ost.

https://www.dnv.com/

COWI

COWI, headquartered in Denmark, provides engineering, architecture, energy, and environmental services. Notable projects include the Codling Wind Park in Ireland, the Ayre and Bowdun Offshore Wind Farms in Scotland, and long-term collaboration with Equinor for offshore wind expansion.

https://www.cowi.com/

#Top 5 Wind Energy Companies in the World

#1 NEXTera ENERGY

Market Cap:
$117.29billion

NextEra Energy, Inc. is recognized as the world's largest wind energy company and a leader in the renewable energy sector, specializing in both wind and solar power. Over the past decade, the company has significantly expanded its wind energy production, tripling its output to become a global benchmark in renewable energy generation. NextEra operates an extensive portfolio of more than 119 wind farms.

https://www.nexteraenergy.com/

#2 IBERDROLA

Market Cap:
$75.62billion

Iberdrola, S.A. is a global leader in wind energy production, with a legacy of over two decades of commitment to clean energy development. The company has set an ambitious target to achieve 52,000MW of renewable energy capacity by 2025. As of the end of 2023, Iberdrola had installed 1,793MW of offshore wind capacity, with an additional 3,000 MW expected to come online by 2027.

https://www.iberdrola.com/home

#3 enel

Market Cap:
$69.12billion

Enel SpA ranks third among the world's largest wind energy companies, reinforcing its leadership in the renewable energy sector. The company operates across diverse segments, including wind, hydroelectric, and energy storage, demonstrating a broad commitment to sustainable energy solutions. Wind energy plays a significant role in Enel's portfolio, contributing approximately one-quarter of its total renewable energy capacity.

https://www.enel.com/

#4

Constellation.

Market Cap:

$53.37billion

Constellation Energy Corporation is a leading producer of clean energy, with a robust portfolio of renewable power generation. Its facilities generate enough energy to supply approximately 15 million homes annually. The company operates 27 wind projects across 10 U.S. states, delivering nearly 1,400MW of wind energy capacity.

https://www.constellation.com/

#5

adani

Market Cap:

$37.42billion

Adani Green Energy Limited ranks fifth among the world's largest wind energy companies, highlighting its prominence in the renewable energy sector. Specializing in both wind and solar energy, the company has established a significant presence in India with 12 wind power plants strategically located across the country.

https://www.adanigreenenergy.com/

Source: Yahoo Finance (2024) | **15 Biggest Wind Energy Companies in the World**

Drivers of Global Wind Energy Growth

Wind energy's emergence as one of the fastest-growing renewable energy sources globally is driven by a confluence of political, economic, and technological factors. These drivers are interlinked, supporting the sector's expansion while addressing climate change and energy security concerns.

Political Drivers

International policies, frameworks, and national targets remain primary drivers of wind energy development. Commitments under global agreements, such as the Paris Agreement and resolutions from COP28, have accelerated the adoption of renewable energy worldwide.

Governments worldwide are setting ambitious renewable energy policies and targets to sustain the momentum for wind energy which is projected at an annual average **installation of 158GW through 2028.**

Key policy and target drivers include:

European Union: The EU has prioritized renewable energy as part of its REPowerEU strategy, targeting a 42.5% share of renewables in its energy mix by 2030. This initiative aims to enhance energy security in response to disruptions caused by geopolitical tensions, such as Russia's invasion of Ukraine.

United States: The implementation of the Inflation Reduction Act (IRA) offers substantial tax incentives and funding for renewable energy projects, including wind. The IRA aims to deliver clean power, strengthen supply chain resilience, and accelerate the transition to sustainable energy.

China: As the world's largest wind energy market, China's clean energy agenda targets the installation of 1,200GW of wind and solar capacity by 2030. This ambitious goal aligns with the global target of achieving carbon neutrality by 2050, further consolidating its leadership in renewable energy deployment.

Offshore Wind Development: Regulatory support for offshore wind is gaining traction. Leasing frameworks in the U.S. and Europe are facilitating the expansion of offshore projects, while policy incentives in Japan and Norway are advancing floating wind technologies, unlocking potential in deeper waters.

achieving carbon neutrality by
2050

42.5%
share of renewables in its energy mix by 2030.

1200 GW
of wind and solar capacity to be installed by 2030

Economic Drivers

Apart from political drivers, economic drivers also play a key role in the development of wind energy globally, these include;

Cost Competitiveness: Wind energy costs have decreased dramatically, with the levelized cost of electricity (LCOE) for onshore wind falling by around 67% since 2009. Offshore wind has also seen significant cost reductions due to larger turbines and economies of scale.

Investment and Financing: Global investments in wind energy exceeded $200 billion in 2023, with increasing contributions from private equity, institutional investors, and green bonds. The expansion of public-private partnerships (PPPs) has also facilitated large-scale projects, particularly in offshore wind.

Job Creation and Economic Development: The wind energy sector supports millions of jobs globally, providing economic benefits to local communities. For example, offshore wind projects in Europe have spurred the development of regional supply chains and port infrastructure.

Technological Drivers

Advancements in Turbine Technology: Innovations in turbine design have significantly improved efficiency and capacity. Modern turbines now exceed 10 MW, with new models and prototypes reaching 15MW, enabling higher energy yields from fewer installations.

Floating Wind Technology: Floating platforms allow wind farms to be installed in deeper waters, unlocking vast offshore wind potential in countries like Japan, South Korea, and the U.S.

Digitalization and Data Analytics:

Technologies like AI, IoT, and predictive maintenance systems are optimizing wind farm operations, reducing downtime, and improving energy output.

Challenges

While it is clear that wind continues to generate great momentum in every corner of the globe and overcome macroeconomic and supply chain difficulties, the current trajectory in wind energy is not sufficient to meet the target of tripling renewable energy capacity to 11,000GW by 2030.

Global wind growth needs to rapidly accelerate, with annual wind installations roughly tripling to at least 320 GW over the course of the decade to meet the COP28 targets. This required pace of installation raises questions and highlights challenges across the areas of investment and financing, supply chain, infrastructure and technical build out, land and seabed availability, social acceptance and more.

While the Market and Geopolitical Forces for wind energy has decreased, the upfront costs of wind farm development-particularly offshore projects-remain significant. These include expenses related to permits, grid connections, and specialized infrastructure.

Energy markets are still heavily distorted by fossil fuel subsidies, which have surged in recent years, largely due to the energy crisis stemming from the Russian invasion of Ukraine. Removing these subsidies is vital to ensure fair competition and accelerate the adoption of zero-emission renewable energy sources.

Volatile demand, geopolitical tensions, rising interest rates, material shortages and fluctuating commodity prices, such as for steel and rare earth elements, have led to increased costs and delays in project timelines impacting the affordability and financial viability of new wind projects leading wind turbine manufacturers to experience negative net margins for seven consecutive quarters thereby resulting in the decline seen in European and North American market. On the other hand, Chinese wind turbine manufacturers, benefitting from strong domestic demand and vertical integration, remain relatively stable amid these global challenges.

From a Regulatory standpoint, policy uncertainty as well as complex permit processes involving lengthy and complicated qualification requirements delay wind energy (often more than other sources of renewable) projects in many regions. For instance, offshore wind developments in Europe and the U.S. often face multi-year approval processes, with wind projects facing long delays of up to 16 months.

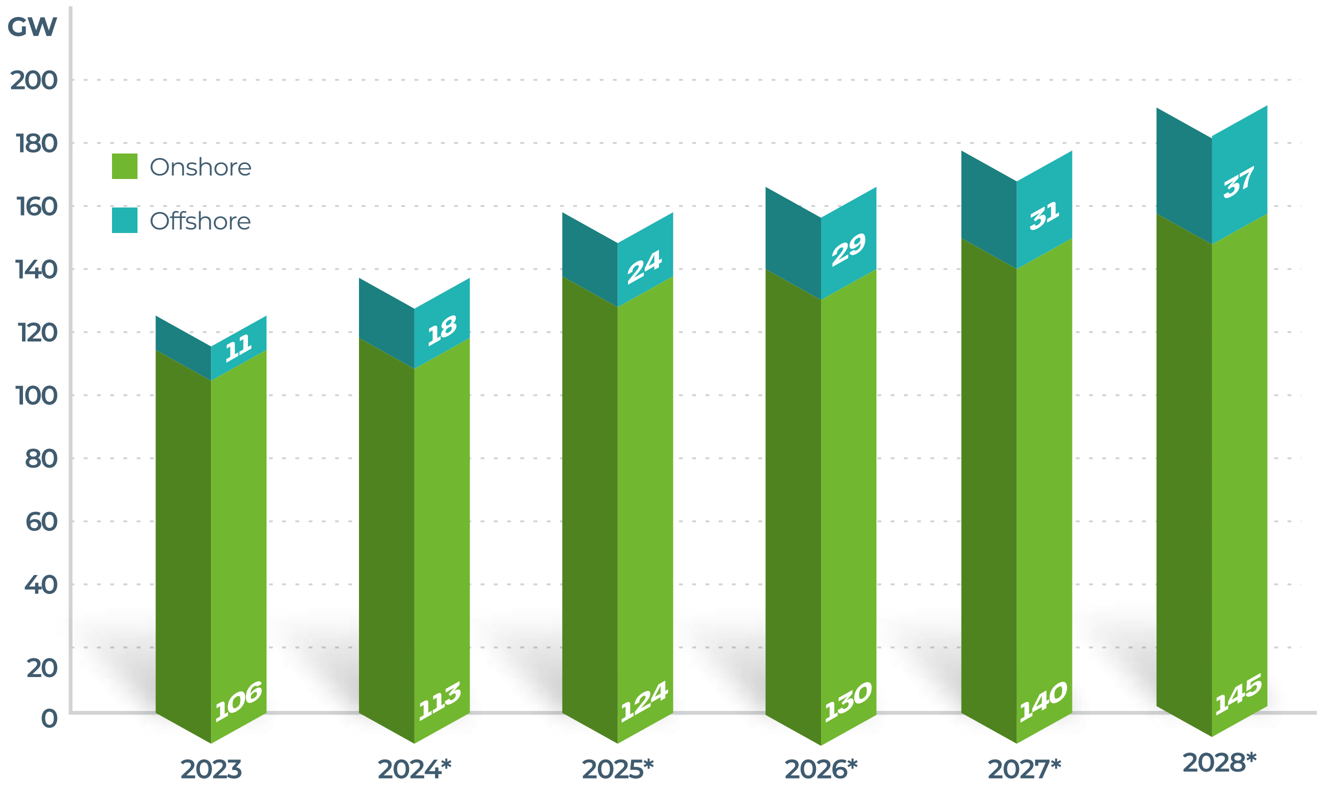
From a Technical and Operational angle, wind energy face challenges related to intermittence and storage. Its output depends on variable weather conditions, requiring advanced energy storage systems and flexible grid management to ensure a consistent supply-demand balance. Additionally, the maintenance and eventual decommissioning of wind turbines, particularly the recycling of composite-material blades, is an emerging operational issue that demands innovative solutions to enhance sustainability.

Global Wind Outlook

By 2050, wind energy is expected to account for 35-40% of global electricity generation, with a substantial share coming from offshore installations. The GWEC projects a bullish future for wind power, with an expected average annual growth rate exceeding 9% over the next five years. By 2028, the global wind power capacity is poised to surge by an additional 791GW, averaging 158GW per year.

China, Europe, and the U.S. are set to remain the principal engines of growth, driven by aggressive clean energy targets and supportive policies such as the Inflation Reduction Act of 2022 (IRA) of the U.S. and the Accelerated Clean Energy Transition in Europe in response to the Russia's invasion of Ukraine. Emerging players in Europe and the Asia-Pacific region are also expected to ramp up their installations.

New Onshore and Offshore Wind Capacity Installed Worldwide in 2023, with a forecast until 2028 (in gigawatts)



* In 2023, new onshore and offshore wind installations worldwide stood at roughly 106 and 11 gigawatts, respectively. It is estimated that global onshore wind capacity additions will amount to 145 gigawatts in 2028, while offshore capacity additions will reach 37 gigawatts.

Source: Statista, GWEC (2024)


Offshore
2023
11 GW
* 2028
37 GW
Onshore
2023
106 GW
* 2028
145 GW

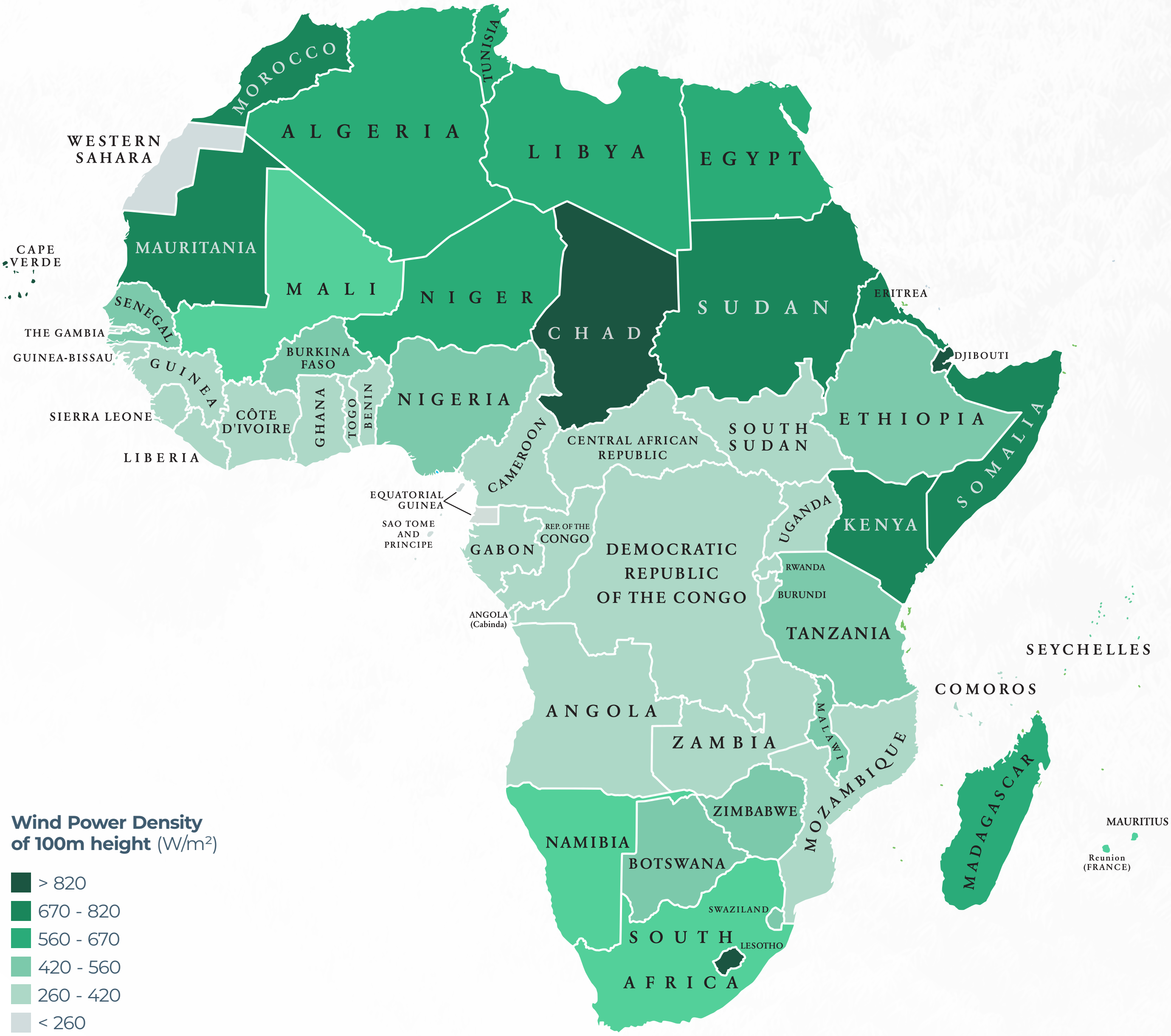
Africa Context on Wind Energy

CHAPTER 02

Overview

Wind energy in Africa is an arising sector, offering significant potential to address the continent's growing energy demand, enhance energy security, and support global climate goals

Wind Power Density at 100m Height (W/m²)



Source: Global Wind Atlas
Development Reimagined (2023) Infographic: Africa's Amazing Wind Power Potential - Development Reimagined

Africa Context on Wind Energy

Africa possesses vast wind energy potential, yet it remains largely untapped, contributing only a minimal share to the continent's overall energy mix. Total installed capacity on the continent is about 9GW, with countries like South Africa, Egypt, and Morocco leading development. Collectively, these countries account for over 80% of the continent's wind power generation.

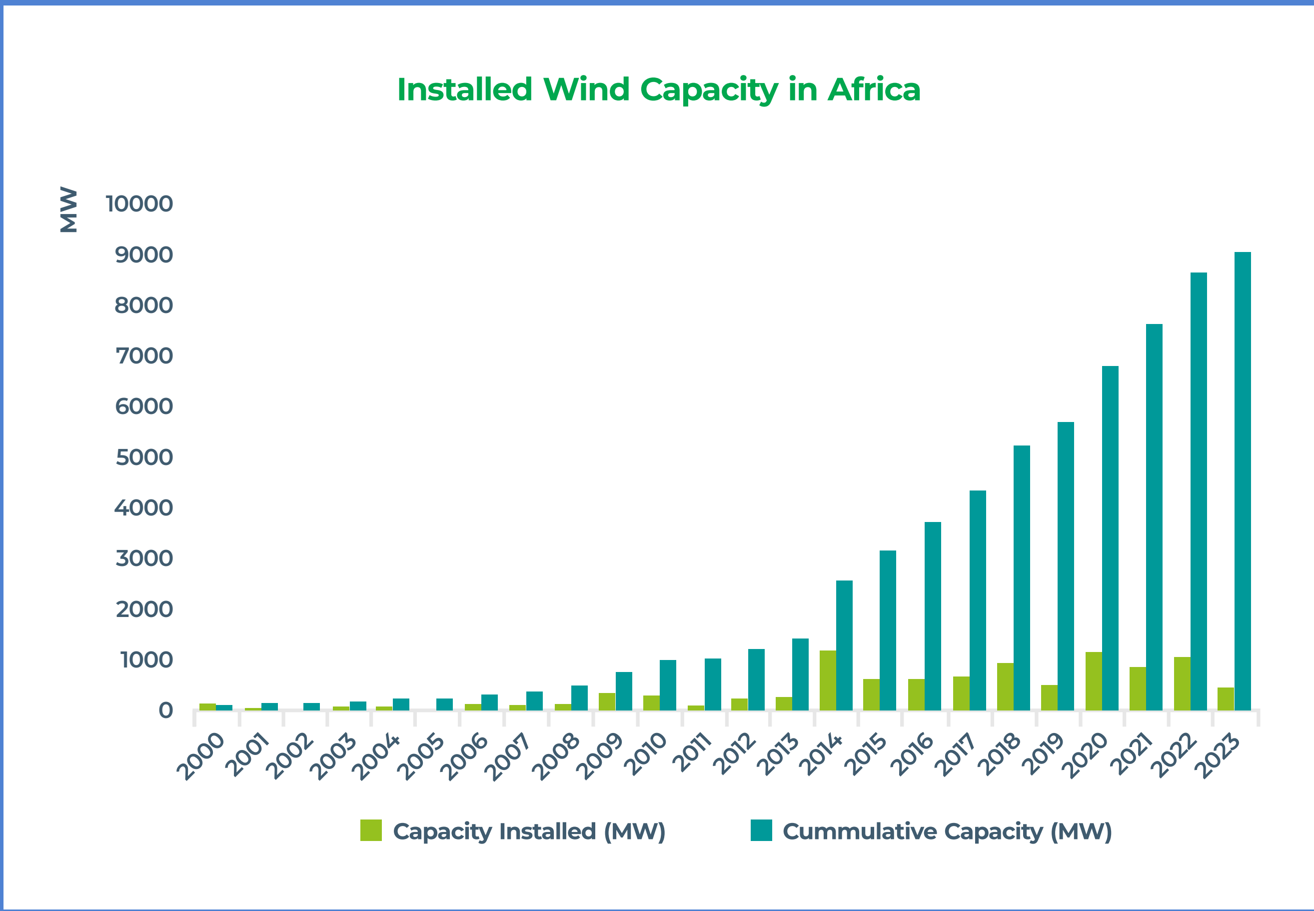
Wind energy development in Africa remains slow, significantly trailing other continents. In 2023, Africa and the Middle East accounted for less than 1% of global new wind energy installations, underscoring the substantial room for growth.

Despite this, wind energy is increasingly being integrated into national renewable energy strategies across the continent. According to the Global Wind Energy Council (GWEC), Africa has a pipeline of approximately 86GW in planned and announced wind energy projects. Notable regional initiatives, such as Senegal's 158.7MW Taiba N'diaye Wind Farm, fully commissioned in 2021, highlight ongoing progress in expanding Africa's wind energy capacity and diversifying its energy mix.

Key drivers of wind energy in Africa include the need for electrification, abundant wind resources, and government -backed renewable energy targets.
However, challenges such as inadequate infrastructure, limited access to financing, and policy inconsistencies hinder growth.

Despite these obstacles, the future outlook is promising, with increasing interest from international investors and regional collaboration, signaling a rise in installed capacity across Africa by 2030.

According to the Global Wind Energy Council (GWEC), Africa has a pipeline of approximately 86GW in planned and announced wind energy projects.



Source: GWEC (2023) GWEC_Status-of-Wind-in-Africa-Report_202310.pdf

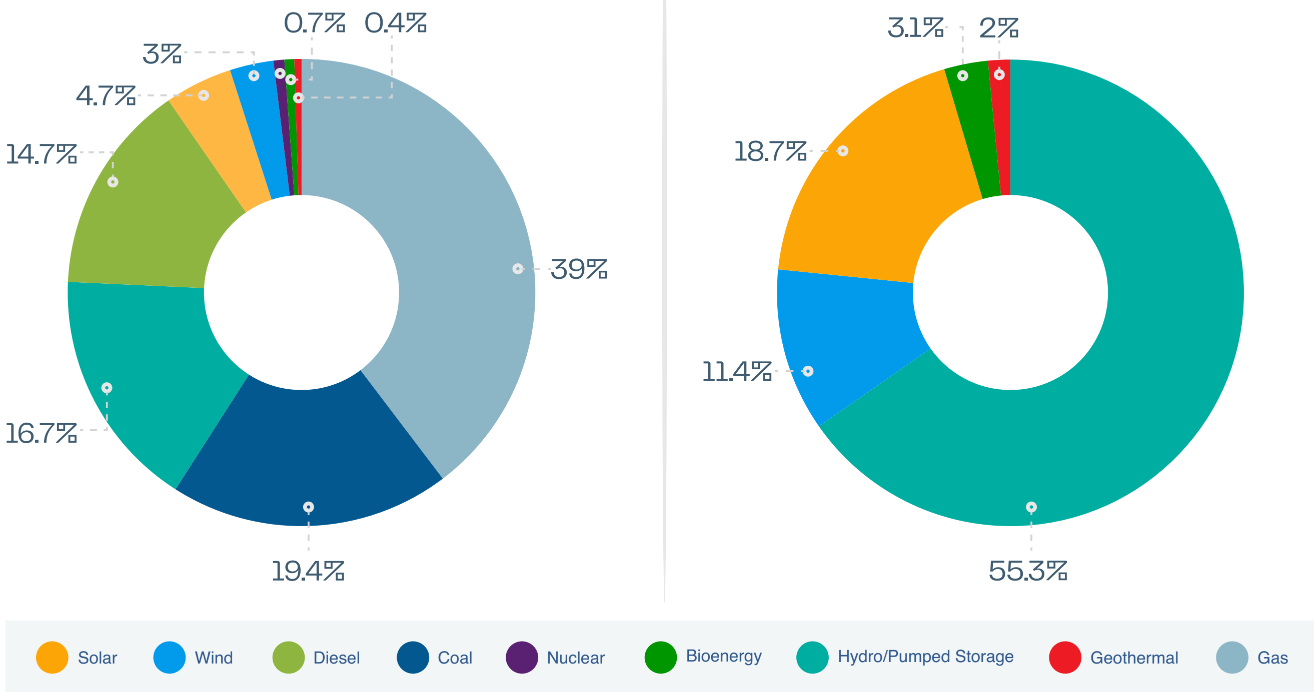
According to the GWEC, Africa has a **total technical potential of 33TW of wind power.** Despite this vast resource, the continent utilizes **only 0.01% of its wind energy capacity.** By 2020, Africa's total installed wind energy capacity was around **6.5GW**, which increased to approximately **9GW** by 2023. This growth reflects contributions from leading countries such as **South Africa, Egypt, and Morocco,** which together account for more than **80% of the continent's total wind power generation.**

Wind energy has increased to around 3% of Africa's energy mix as of 2021, underscoring its growing role in regional electrification efforts. However, from a global perspective, Africa and the Middle East together accounted for less than **1% of new wind energy installations in 2023,** indicating substantial untapped potential and opportunities for improvement. These figures highlight both the progress made and the need for continued investment and policy support to harness Africa's abundant wind resources effectively.

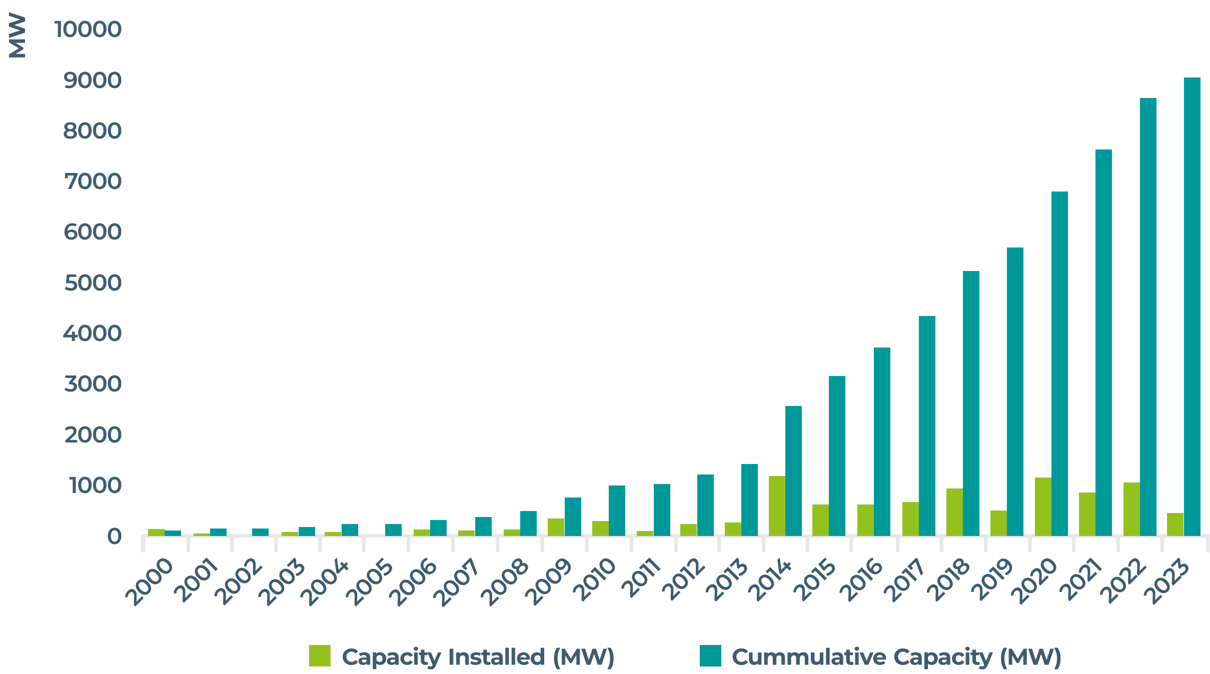
The **158.7 MW Taiba N'diaye wind Farm (PETN) in Senegal** (biggest wind farm in Western Africa) developed by Lekela Power to provide power for over 2 million Senegalese is worthy of mention.

Share of Energy Production in Africa 2021 by Source

Africa's Installed Renewables Energy Capacity 2020 by Technology

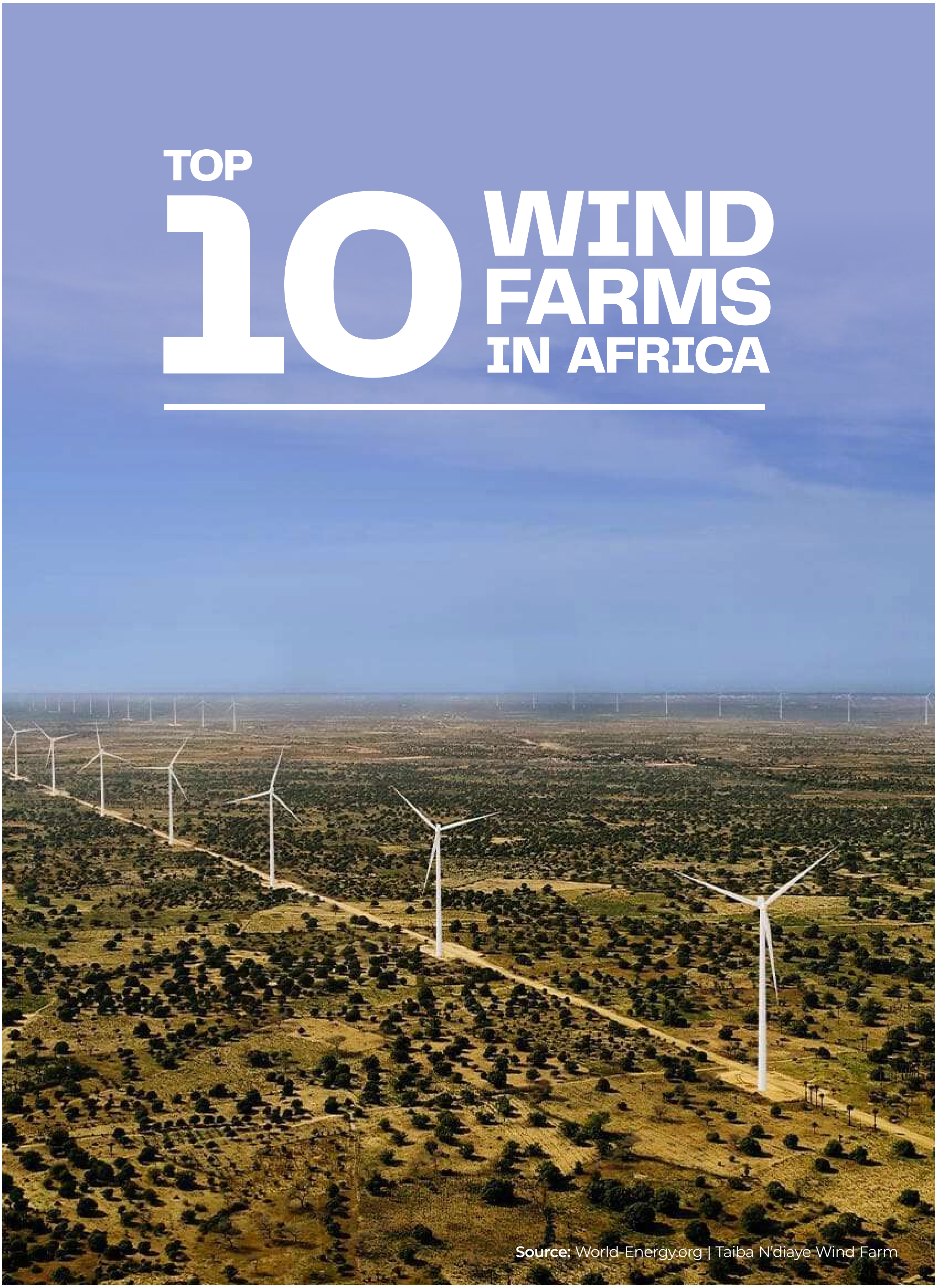


Installed Wind Capacity in Africa

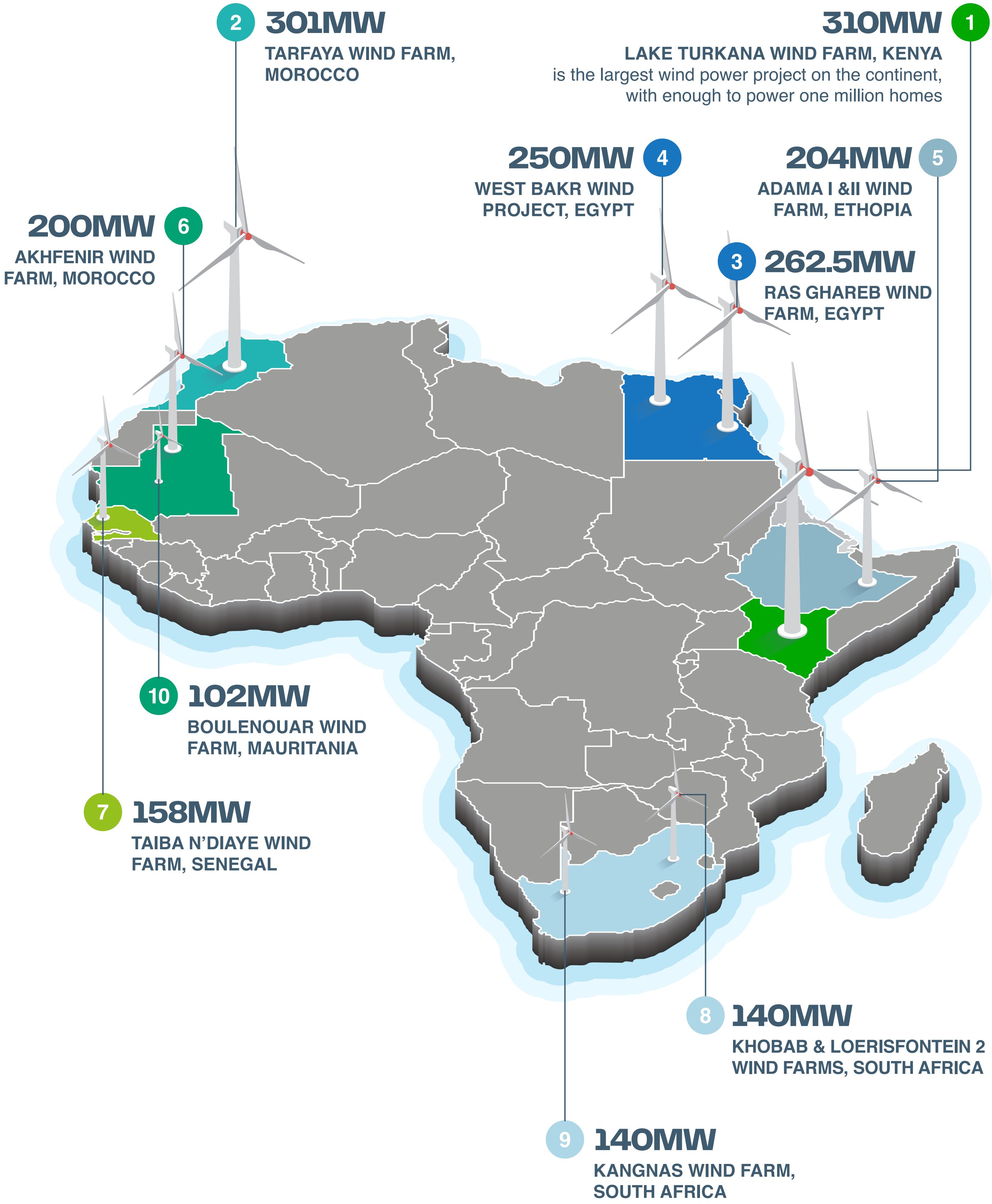


Source: GWEC (2023) GWEC_Status-of-Wind-in-Africa-Report_202310.pdf

TOP 10 WIND FARMS IN AFRICA

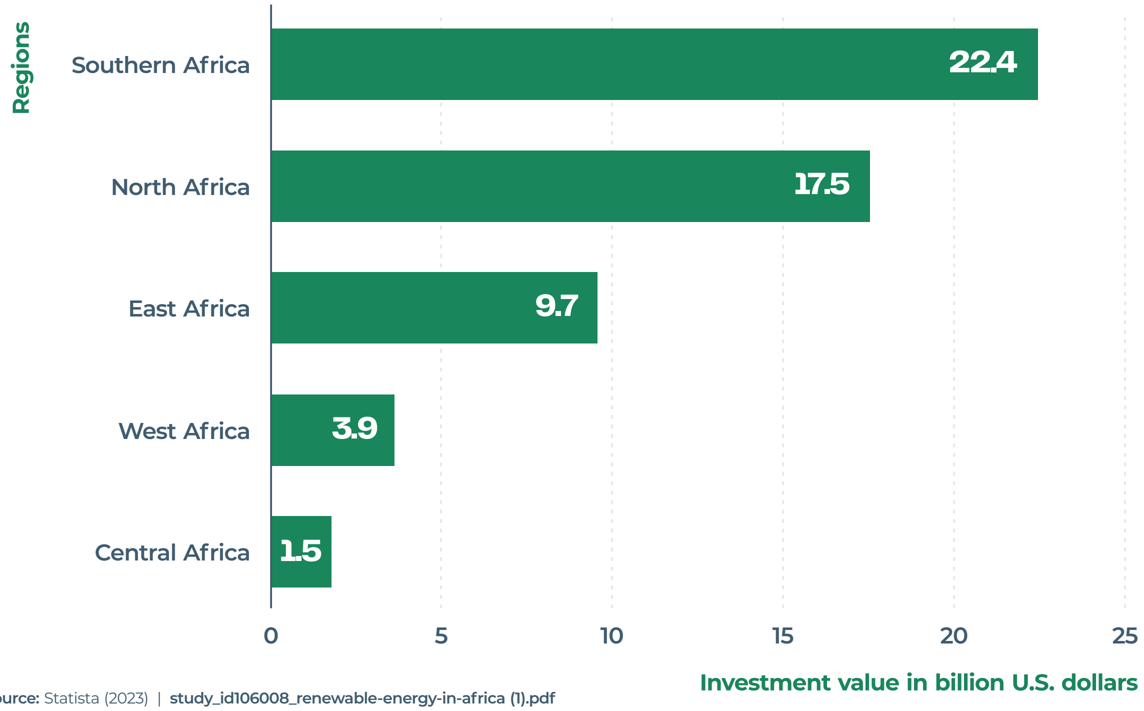


Source: World-Energy.org | Taiba N'diaye Wind Farm



Source: Energy Capital & Power | MustardInsights (2023) Wind power in Africa: Struggles, Opportunities, and Successes

Value of Renewable Energy Investment in Africa between 2010 and 2020, by Region (in billion U.S. dollars)



Source: Statista (2023) | **study_id106008_renewable-energy-in-africa (1).pdf**

Wind energy development in Africa has been significantly constrained by various factors and currently lags behind solar photovoltaic (PV) adoption. Governments, energy ministries, utilities, and power planners often prioritize solar PV due to its perception as cheaper, faster, and simpler to deploy. Fossil fuel generation also remains a dominant part of the energy mix, further slowing the transition to wind energy. This is despite recent wind resource assessments revealing far greater potential than previously estimated.

According to a study by the International Finance Corporation (IFC), the private sector arm of the World Bank Group, Africa possesses an exceptional onshore wind energy potential of nearly 180,000 terawatt hours (TWh) per year-enough to meet the continent's electricity demand 250 times over.

While there is a lack of both investable projects, and a lack of seed capital needed for early stage developers to get projects off the ground and to reach the stage where a wind project is considered bankable, countries across the continent are increasingly integrating wind energy into their renewable energy strategies with a total of 86GW of planned and announced wind projects across the continent according to the GWEC.

Regional Highlights

Northern Africa
4165MW

Top 5 Projects by size

- 580MW Jabal al-Zeit Wind complex, Egypt
- 544MW Zafarana Wind Complex, Egypt
- 301MW Parc Ealien Boujdour, Morocco
- 301MW Parc Ealien de Tarfaya, Morocco
- 262.5MW Ras Gharib Wind Farm, Egypt

Southern Africa
3663MW

Top 5 Projects by size

- 148MW Nxuba Wind Farm, South Africa
- 147.6MW Oyster Bay Wind Farm, South Africa
- 147MW Karusa Wind Farm, South Africa
- 147MW Soetwater Wind Farm, South Africa
- 147MW Roggeveld Wind Farm, South Africa

Eastern Africa
950MW

Top 5 Projects by size

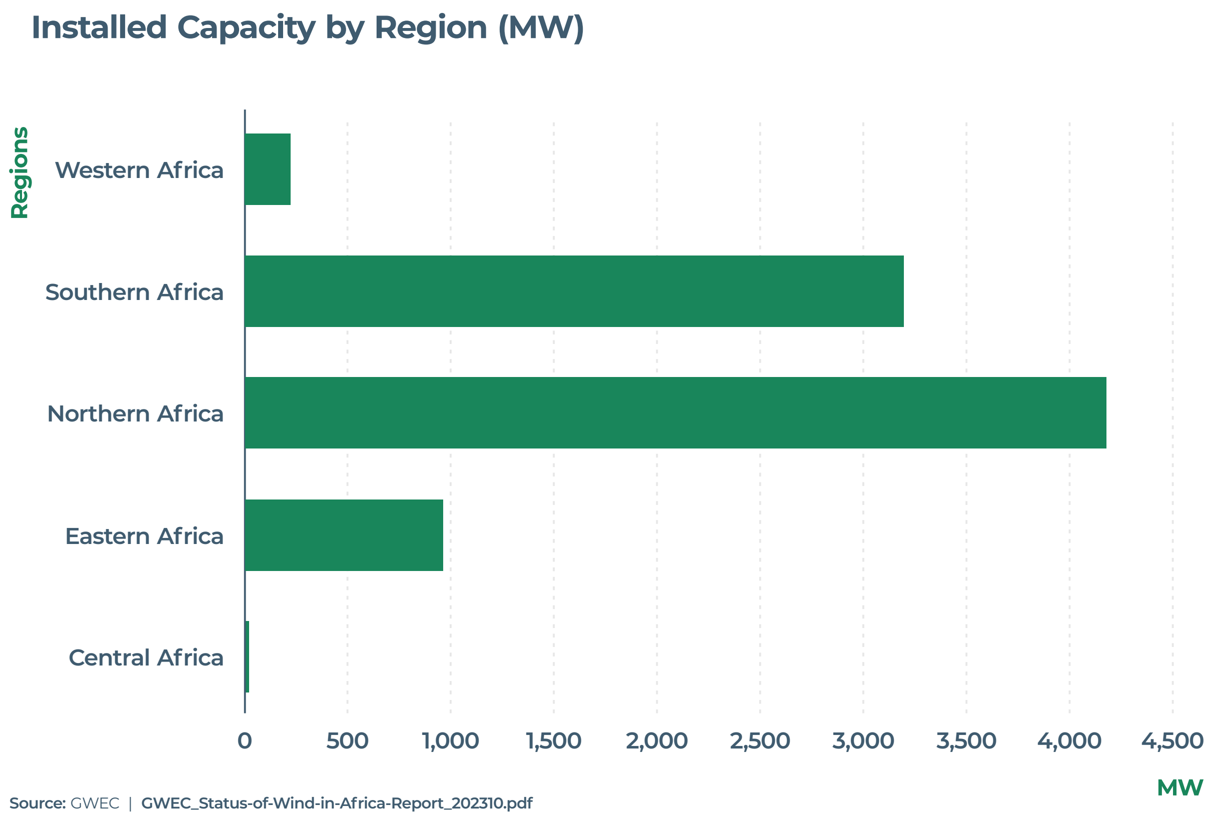
- 310MW Lake Turkana Wind Power, Kenya
- 204MW Adama I & II Wind Farm, Ethiopia
- 120MW Ashegoda Wind Farm, Ethiopia
- 120MW Aysha Wind Farm, Ethiopia
- 102MW Kipeto Wind Farm, Kenya

Western Africa
296MW

Top 5 Projects by size

- 158MW Taiba N'diaye Wind Farm, Senegal
- 30MW El Mina Wind Farm, Mauritania
- 10MW Katsina Wind Farm, Nigeria
- 9.35MW Santiago Wind Farm, Cape Verde
- 7.65MW Sal Wind Farm, Cape Verde

Source: Statista (2023) | **GWEC_Status-of-Wind-in-Africa-Report_202310.pdf**



North Africa

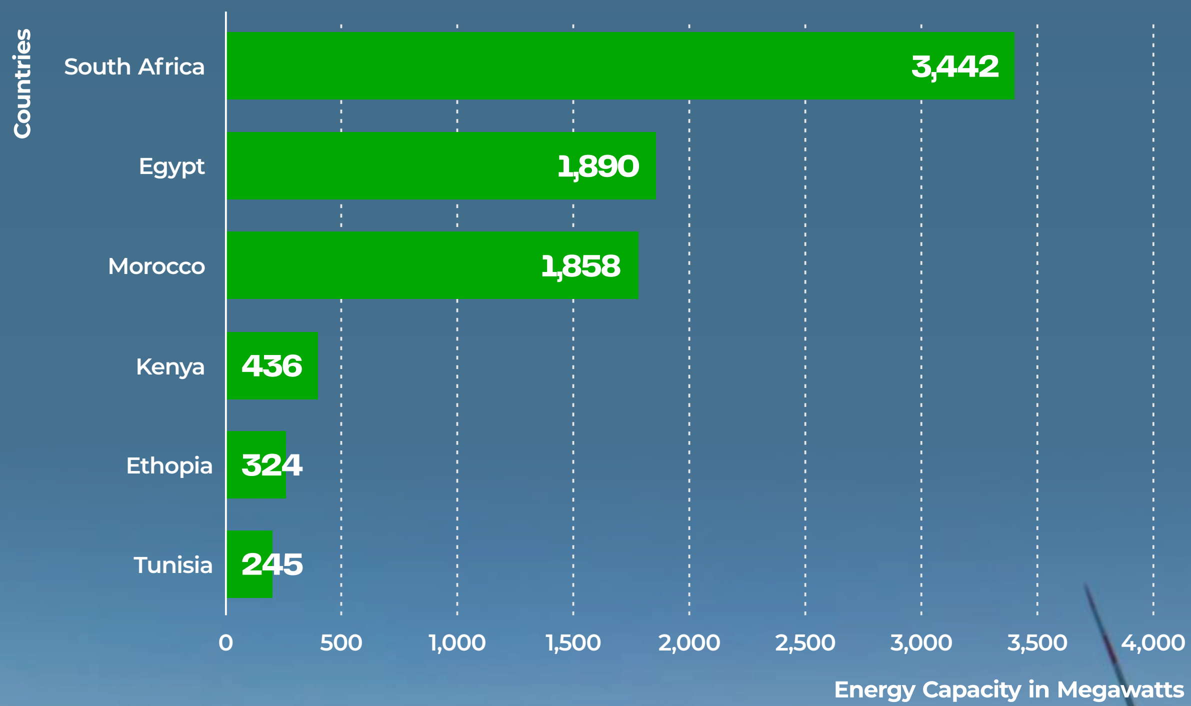
Considering the five sub-regions of Africa, North Africa leads in terms of total installed capacity due to the influence and early onset of renewable energy programs in Egypt and Morocco which saw initial utility-scale wind project commissioning in 1988 and 2000, respectively.

Morocco currently leads the North African region with more than 1.5 GW of installed capacity, driven by projects like the Tarfaya Wind Farm, one of the largest in Africa. Egypt also has substantial capacity, with plans to expand projects near the Gulf of Suez. Egypt and Morrocco also led the charge for new wind installations for the African and Middle East region in 2023 with 360MW and 138MW of new installations respectively.

Sub-Saharan Africa

The Southern African region, dominated by wind farms in South Africa who possess over 3 GW of wind power capacity largely realized through the Renewable Energy Independent Power Producer Procurement Program (REIPPPP) scheme, has the second highest installed wind capacity. Eastern Africa comes in third with several operational wind farms in Ethiopia and Kenya (which operates Africa's largest wind farm, the Lake Turkana Wind Power Project, with 310 MW capacity, providing nearly 15% of the nation's electricity.)

Wind Energy Capacity in Selected African Countries in 2023



Source: Statista | **IRENA (2023) study_id106008_renewable-energy-in-africa (1).pdf**

Drivers of Wind Energy in Africa

The development of the wind sector in Africa is tied to policy interest, the availability of wind resources as well as significant energy deficit. African countries are choosing to implement wind farms to achieve their climate goals and power supply needs.

Additional Capacity and Grid Stabilization

Africa has a significant electricity shortfall with about 43% of its total population lacking access to electricity. That energy demand that needs to be met is one of the primary factors fuelling the growth of alternative energy sources like wind power. Wind power is increasingly becoming a major part of various African nation's energy mix. For example, the Lake Turkana wind farm contributes 17% of Kenya's installed capacity while the Taiba N'diaye wind farm increased Senegal's installed capacity by 15%. Wind farms provide needed capacity and energy to increase the level of electricity supply in the countries looking to expand supply and access to electricity with the added benefit of supplying renewable power.

Wind power is also seen as a complimentary solution to solar PV for grid stabilization and off-grid solutions. In terms of grid stabilization, wind and solar show complementarity with the daytime dips in wind being complimented by peaks in solar and loss of solar in the night matched with strong wind supply in the night. With much of African electricity transmission or distribution infrastructure left to be desired, solar and wind power solution mix presents an opportunity to provide electricity without investment into an inconsistent grid system thus driving the growth of wind power demand.

Wind Power Falling Cost, Improved Technologies and Political Commitment

Much of the global drivers for the growth of wind power applies to the African region as well. As mentioned earlier LCOE for onshore wind fell by 67% since 2009 and experts predict a further 37% to 49% decline in wind energy cost by 2050. These cost reductions have and are expected to continue to allow wind to play a larger role in energy supply for developing countries and make wind increasingly competitive with fossil fuels.

Advancements in turbine design (e.g., larger, more efficient models) and floating offshore wind technology has unlock new opportunities in deep-water regions, expanding the geographic scope of viable wind projects and increased the use case and efficiency of the energy solution while African governments much like the rest world have committed to the global initiatives and plan to tackle climate and restrict global warming of which renewable energy would play a major part. Political Commitment and plans like Nigeria's Energy Transition Plan (ETP), and Ghana's Energy Transition and Investment Plan which detail pathways and targets for various African countries to achieve net zero emission influences and drives the growth of wind energy in Africa.

Africa has a significant electricity shortfall with about **43% of its total population lacking access to electricity.**

Wind farms provide needed capacity and energy to increase the level of electricity supply with the added benefit of supplying renewable power.

Challenges

While wind energy in Africa holds immense potential, the African region faces a myriad of challenges that affects its adoption, integration and growth in the region. These challenges range from infrastructure deficits to policy and regulatory barriers to financial constraints, low economic viability and environmental and social concerns.

Many African countries have grid infrastructural challenges, which is often outdated or incapable of integrating variable wind power. For example, nations like Kenya and South Africa face constraints in connecting new wind farms to their grids due to insufficient transmission capacity. Expanding wind energy to rural areas via grid extensions can be very costly which can be a deterrent for investors. Wind energy projects, especially offshore, require specialized ports, roads, and equipment for construction and maintenance. Countries with limited infrastructure struggle to develop these large-scale projects efficiently

From a regulatory perspective, policy environments in many African nations lack stability, which discourages long-term investment in wind energy. Inconsistent incentives and regulations can lead to uncertainty, undermining confidence in the sector. Bureaucratic delays in obtaining permits and approvals particularly for large-scale wind farms requiring multiple approvals at local, regional, and national levels and land ownership and zoning issues prolong project timelines and complicate the development process. Fossil fuel subsides in some regions with abundant fossil fuel resources affect the competitiveness of wind energy solutions.

From a financial perspective, renewable energy projects as whole are often associated with high-risk profiles due to various reasons including political instability, economic volatility, and currency fluctuations in some regions. This perception limits access to international financing. This is reflected in recent investment numbers in the region as only 2% of global investment in renewables in the last two decades were made in Africa, despite its vast potential wind and solar resources, and even then, investment activity largely targeted a handful of countries. Even at that domestic funding is also an issue as Local banks and investors often lack the capacity or willingness to fund large-scale renewable energy projects, leading to heavy reliance on international institutions increasing the projects exposure to external economic factors. While operational costs for wind farms are low, the upfront investment required for development and infrastructure, particularly for offshore wind projects, remains a significant barrier.

Lack of technical expertise required for the development and maintenance of wind project on the continent poses a challenge for the technology's growth, this in addition to the continuous dependence on imported technologies which increases cost and project timelines highlight the technological and knowledge gaps that add to the challenges of wind energy on the Many African countries have limited grid infrastructure, which is often outdated or incapable of integrating variable wind power.

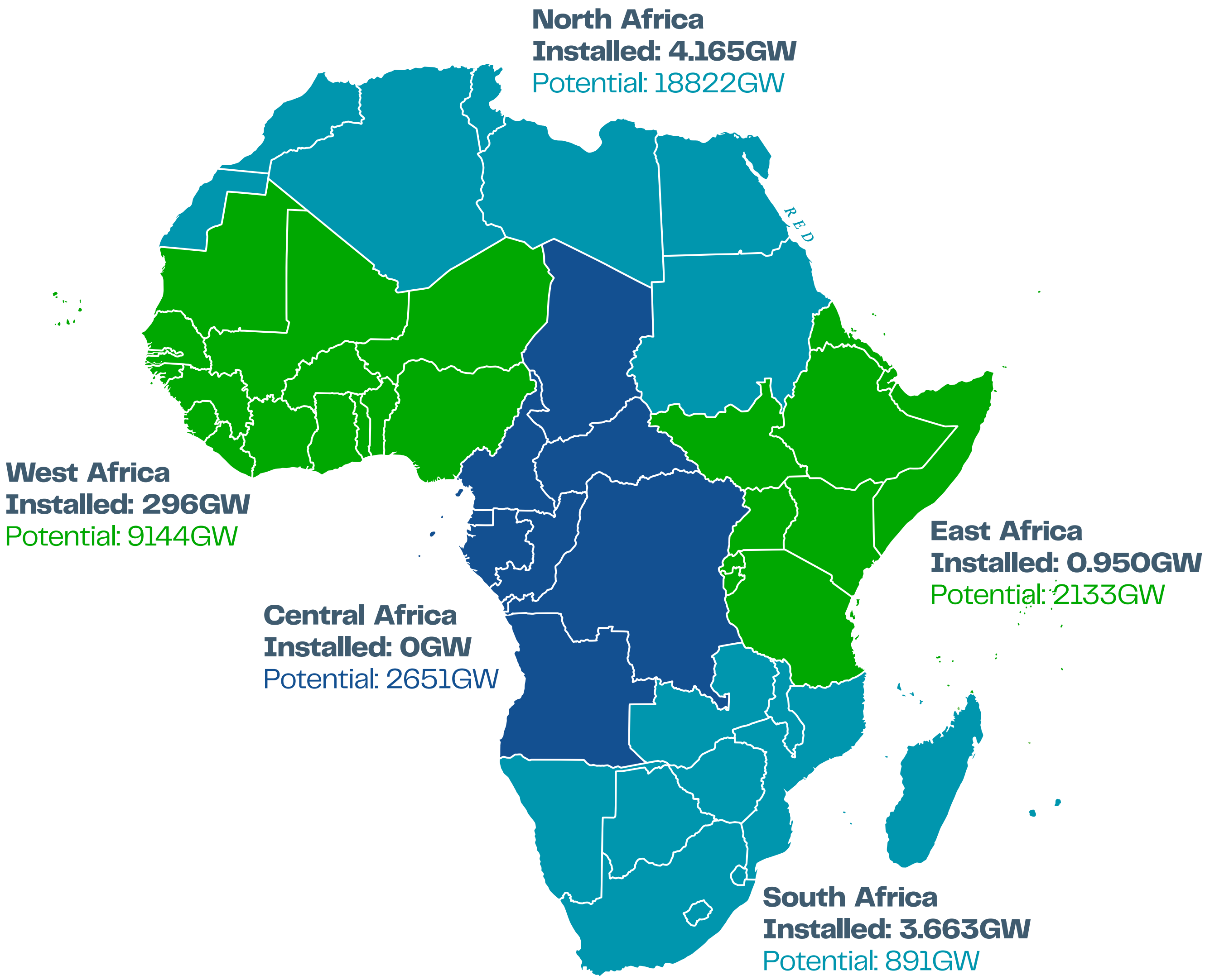
Many African countries have limited grid infrastructure, which is often outdated or incapable of integrating variable wind power.

Africa Wind Outlook

The future of wind energy in Africa is promising, driven by increasing energy demand, ambitious renewable energy targets, and a growing recognition of wind energy as a cost-effective and sustainable solution to the continent's energy challenges. By leveraging its vast wind resources, Africa has the potential to emerge as a key player in the global renewable energy landscape.

Africa's installed wind energy capacity is projected to more than double by 2030, with the Global Wind Energy Council (GWEC) estimating an additional 15.8GW by 2028. This expansion will be driven by increased investments, supportive regulatory frameworks, and international collaboration. Contributing to this growth are approximately 140 planned wind energy projects across the continent - including in Angola, Chad, Mali, Ghana, Uganda, and Malawi -representing a total of 86 GW of proposed new capacity.

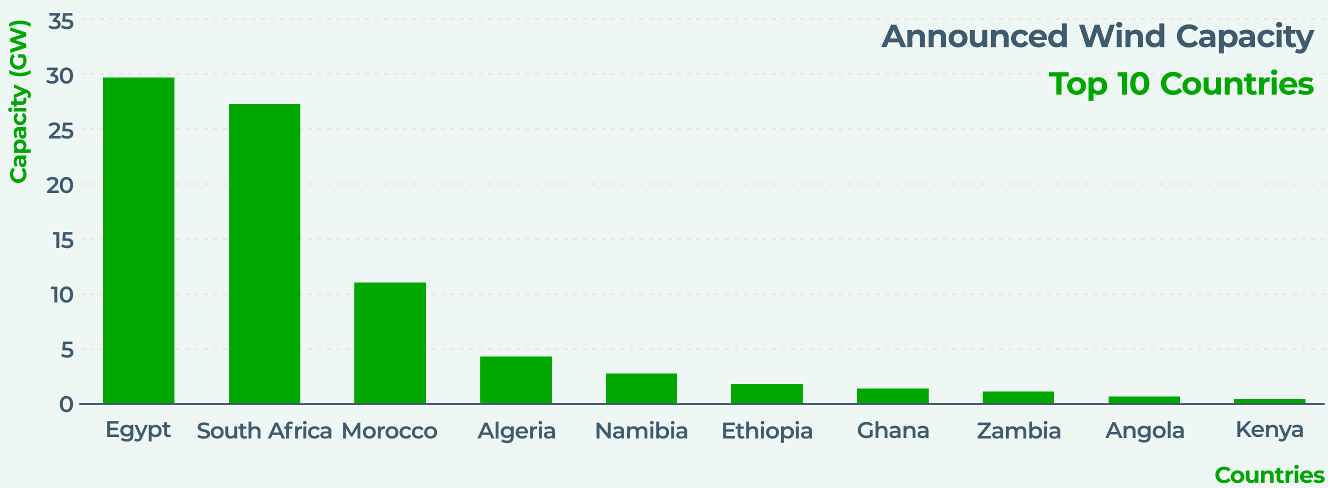
While onshore wind dominates current



Source: GWEC (2023) | **GWEC_Status-of-Wind-in-Africa-Report_202310.pdf**

capacity, offshore wind offers immense untapped potential, particularly in countries with long coastlines, such as South Africa, Namibia, and Morocco. The advent of floating wind technology is expected to unlock additional opportunities in deep-water regions.

Egypt looks set to dominate the wind sector in Africa over the coming decade considering its significant technical potential, existing installed capacity, established local manufacturing industry (e.g. steel towers, electrical switchgear, and cabling) and numerous recently announced projects. The Government of Egypt notably announced at COP27 the signing of agreements for one of the world's largest wind farms, a USD 10 billion, 10GW wind farm in the Gulf of Suez region.



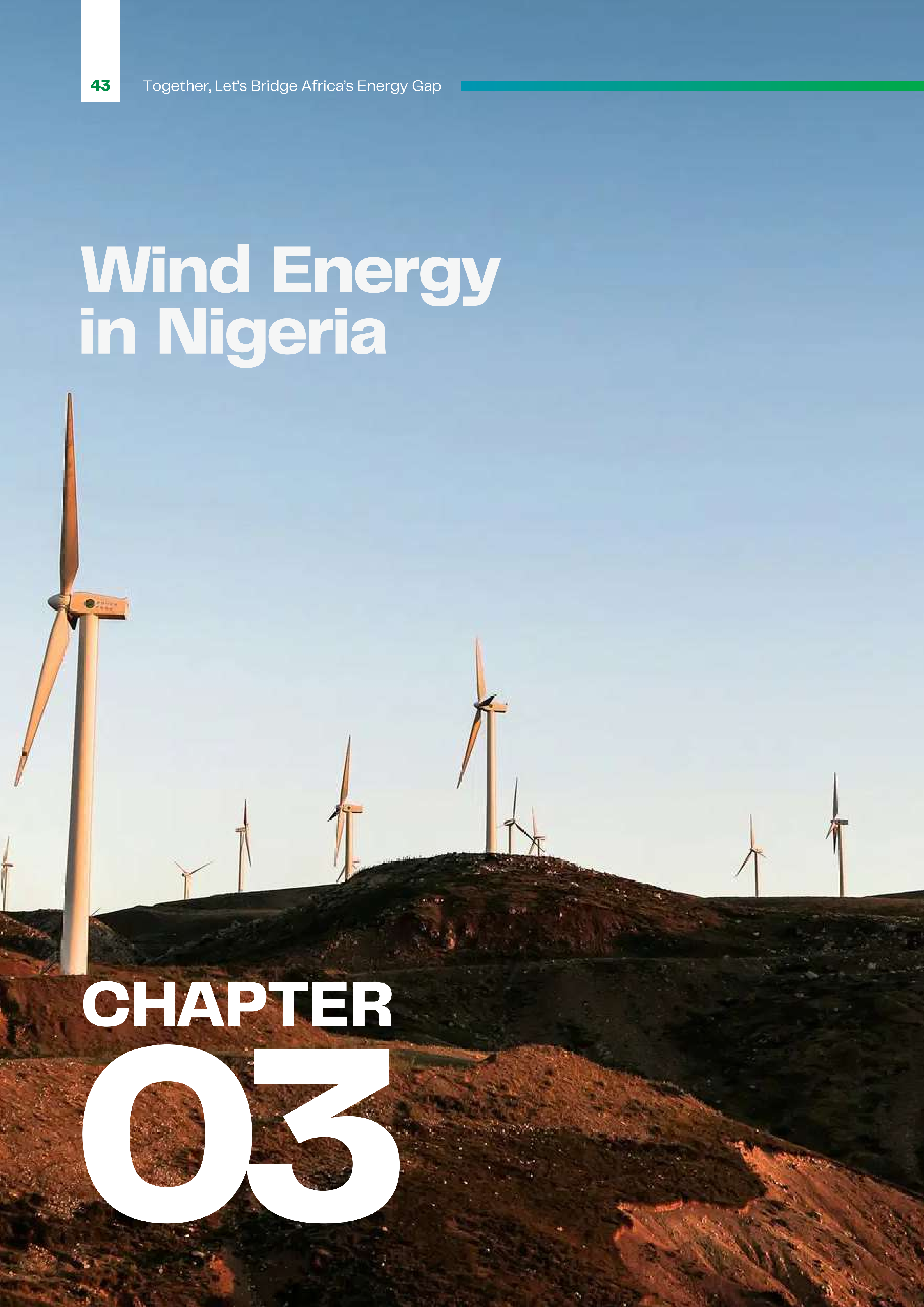
Source: GWEC (2023) | GWEC_Status-of-Wind-in-Africa-Report_202310.pdf

The future could also see the emergence of new wind markets such as Ethiopia, Senegal, and Namibia in Africa.

Africa's population is projected to reach 2.5 billion by 2050, with a corresponding increase in energy needs. Wind energy would continue to be seen as a scalable and reliable solution to meet this demand while reducing dependence on fossil fuels. However, while many African countries have integrated wind energy targets into their Nationally Determined Contributions (NDCs) under the Paris Agreement and put policies in place to accelerate renewable growth (Solar PV and Wind), they have met these goals with varying degrees of success.

Numerous barriers would need to be overcome to achieve these targets to see the integration of wind power into Africa's energy mix. Addressing financing constraints, infrastructure deficits, and regulatory hurdles will be critical for sustaining wind energy growth in Africa.

Wind Energy in Nigeria



CHAPTER 03

Overview

Nigeria's wind energy sector holds significant potential to diversify the country's energy mix, reduce reliance on fossil fuels, and address its acute power shortages. According to the World Bank, 86 million Nigerians don't have access to grid electricity representing 43% percent of the country's population and making Nigeria the country with the largest energy access deficit in the world and significantly affecting the livelihood and productivity of the nation. This has forced Nigeria like many nations to look for alternative source of electricity not to clean up its energy mix but to satisfy its energy shortage and growing demand.

		Primary Source of Electricity (% of households)						Other Sources of Electricity (% of households)					
Region	No Electricity	National Grid	Mini Grid	Generator	Solar System/ Lantern	Rechargeable Battery	Other	National Grid	Mini Grid	Generator	Solar System/ Lantern	Rechargeable Battery	Other
North Central	47.0	94.0	0.0	4.5	0.0	0.9	0.6	2.6	0.2	11.0	0.4	5.3	0.0
North East	79.1	83.0	0.0	1.5	4.9	10.1	0.4	6.7	0.0	4.2	0.1	0.0	0.0
North West	59.7	97.3	0.0	1.6	0.8	0.3	0.0	1.5	0.0	5.8	0.5	2.9	0.0
South East	28.6	74.4	0.0	20.7	0.0	3.8	1.1	14.5	0.3	20.3	0.8	6.7	0.0
South South	27.2	70.6	1.1	24.1	1.2	0.4	2.6	7.6	0.0	14.7	0.2	1.9	0.0
South West	32.7	97.6	0.0	2.4	0.0	0.0	0.0	0.8	0.0	10.2	0.1	0.0	0.0
Urban	16.1	92.4	0.0	6.3	0.1	0.1	0.3	4.1	0.1	16.3	0.5	2.4	0.0
Rural	57.6	79.2	0.5	15.8	1.1	1.1	1.5	7.3	0.1	9.0	0.3	3.7	0.0
Nigeria	44.6	85.4	0.3	11.3	0.6	0.6	0.9	5.8	0.1	12.4	0.4	3.0	0.0

Source: LSMS Integrated Surveys on Nigeria General Household Survey Panel, Wave 4 (2019) – Collaboration between National Bureau of Statistics and the World Bank

86 million Nigerians don't have access to grid electricity. This represents **43 percent** of the country's population, making Nigeria the country with the largest energy access deficit in the world.

Nigerian Context and Deep Dive

Nigeria's wind energy potential remains largely untapped, despite the availability of strong wind resources, particularly in the northern regions. Current wind energy contributions are negligible, with most renewable energy initiatives focusing on solar power. Challenges such as inconsistent policy frameworks, high project costs, and limited technical capacity impede progress. Yet, Nigeria's need for reliable and clean energy, coupled with growing investor interest, positions the country for potential wind energy breakthroughs.

The country faces a significant energy deficit, with 44.6% of households lacking access to electricity. This gap is most pronounced in the Northwest, where nearly 60% of households remain unconnected to the grid, while the Southsouth region has the lowest gap at 27%. Urban centers such as Lagos State present a strong market opportunity for wind energy due to their high population density, extensive commercial activities, and industrial demand. Prominent near shore areas like Badagry, Ilashe, and Ibeche beaches have been identified as having favorable wind profiles for potential wind farm development.

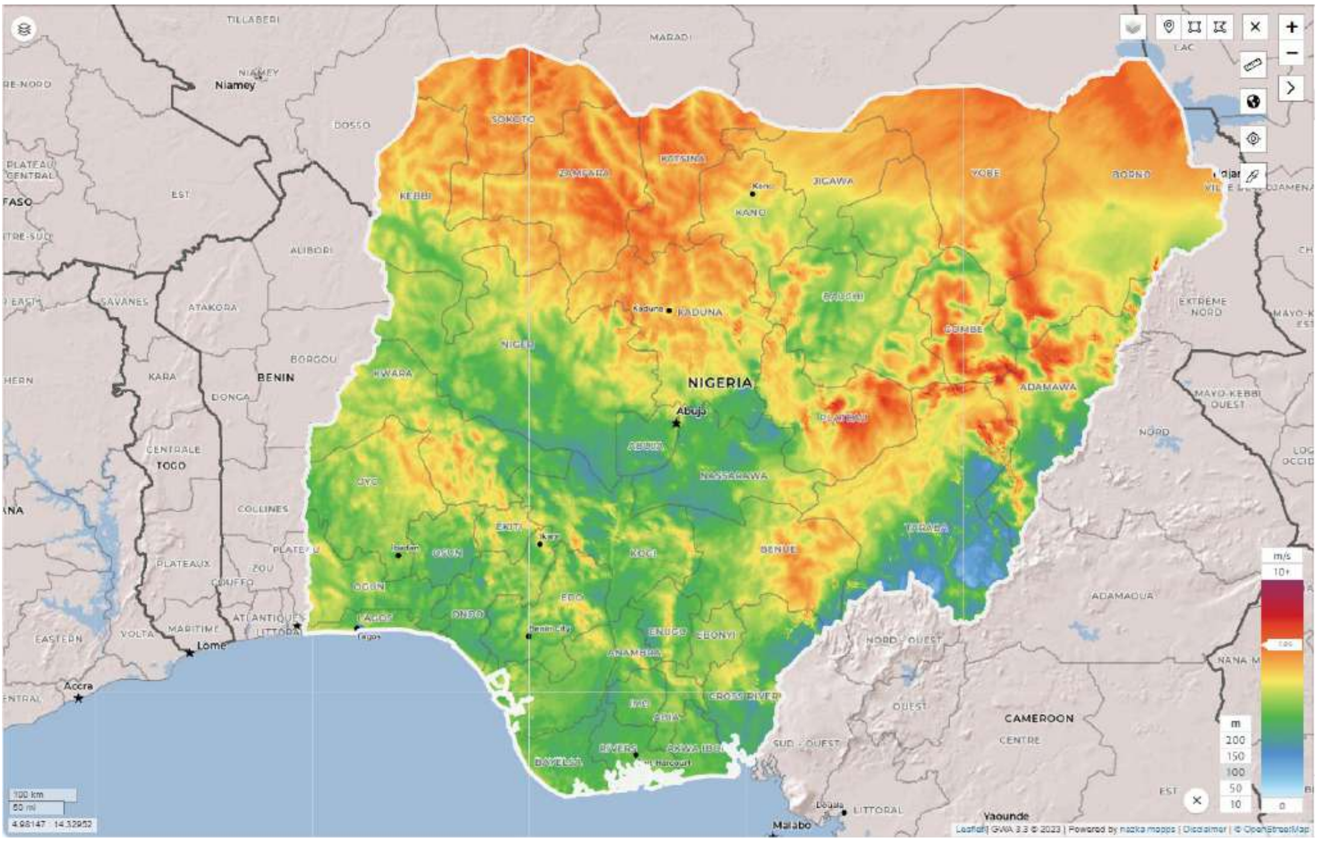
Previous studies indicate that the Northern highlands of Jos and Mambilla Plateau exhibit the best wind profiles, with wind speeds exceeding 7 m/s, while the Southern coastal regions also show promise at higher altitudes. Data from open-source platforms such as The Global Wind Atlas and Vortex reveal an average wind speed of 6.79 m/s at 100m height, with a mean power density of 294 W/m², indicating a viable foundation for wind energy development.

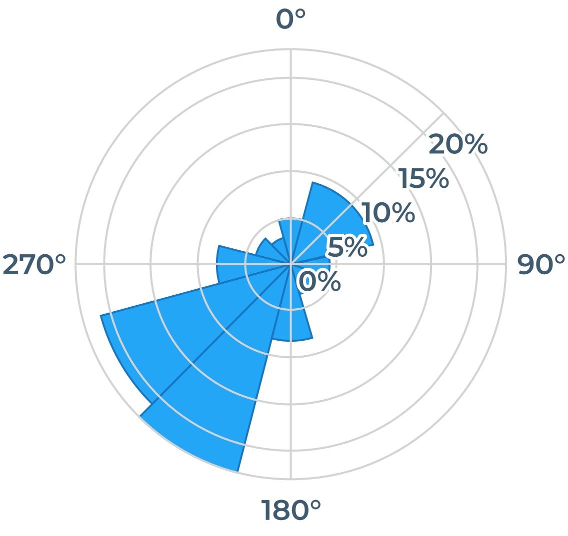
Geographic assessments further underscore regions such as the Yorro Highlands in Taraba State, where wind speeds reach up to 12.07 m/s and power densities peak at 1,814 W/m², as well as Pankshin in Plateau State, with wind speeds of 10.90 m/s and a power density of 1,453 W/m². Conversely, states like Akwa Ibom and Rivers exhibit lower wind speeds averaging around 4.3–4.39 m/s, making them less suitable for large-scale wind energy projects.

The predominant wind direction across Nigeria is toward the Southwest, as reflected in wind rose analyses, offering critical insights for the orientation of wind turbines.

These findings highlight the substantial potential for wind energy development in Nigeria, particularly in regions with high wind speeds and significant energy deficits, while emphasizing the need for targeted policies and investments to harness these resources effectively.

Nigeria's wind energy potential remains largely untapped, despite the availability of strong wind resources, particularly in the northern regions.





The country faces a significant energy deficit, with

44.6% of households lacking access to electricity

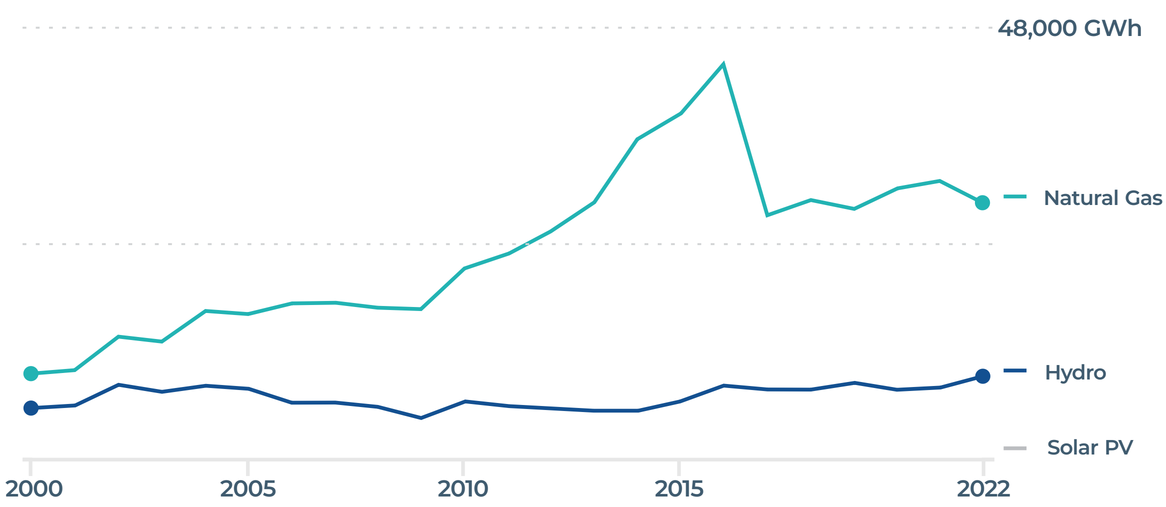
While the nation has made some inroads to using Solar PV as an alternative source of energy, wind power remains underutilized, contributing less than 1% to the national energy output despite a moderate wind regime with speeds of 4–7.5 m/s in regions like the North and coastal areas.

There have been several projects to take advantage of the wind power, including the 10MW Katsina Wind Farm, and innovations such as vertical-axis turbines highlight emerging opportunities.

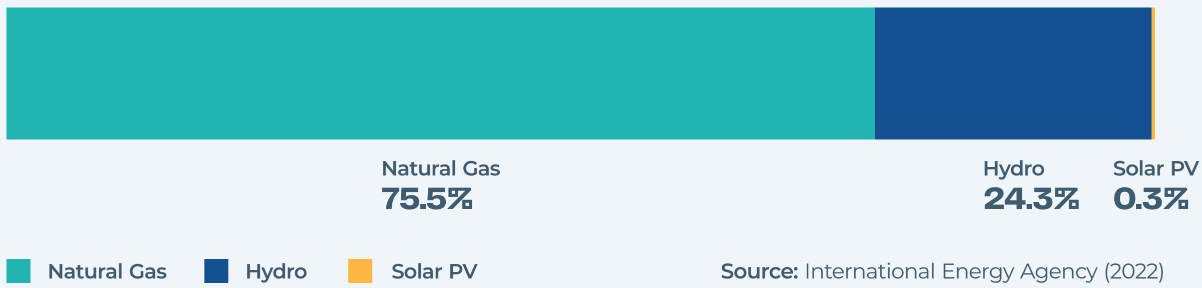
However, challenges persist, including high capital costs, regulatory hurdles, inadequate grid infrastructure, and limited local manufacturing. Supportive policies like the Renewable Energy Master Plan and targeted funding from agencies such as the Rural Electrification Agency offer a framework for growth. To fully harness wind energy, Nigeria must address these barriers through enhanced policy implementation, infrastructure investments, and local capacity development, paving the way for a sustainable and resilient energy future.

Situational Highlights

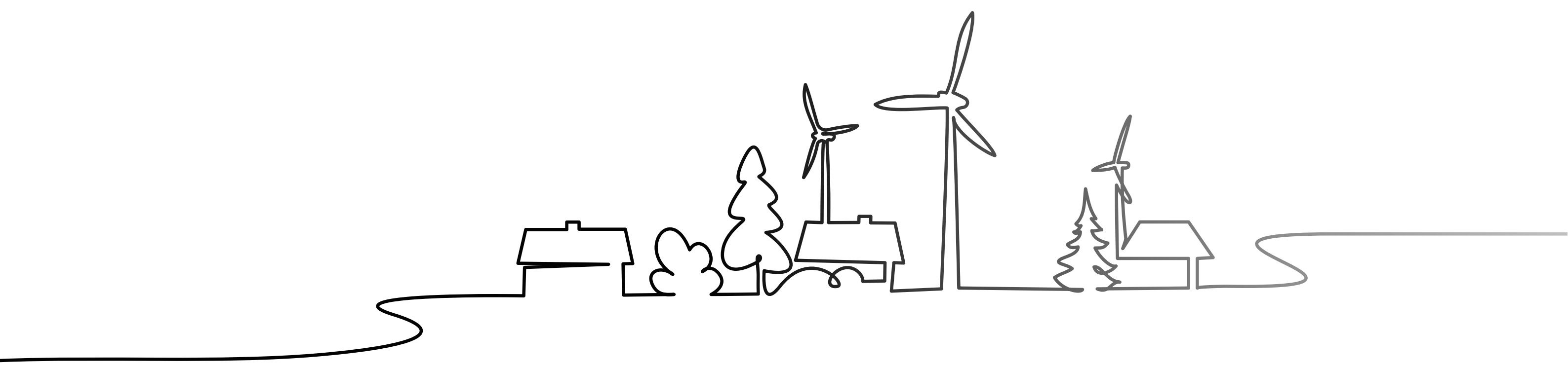
Evolution of Electricity Generation Sources in Nigeria since 2000



Electricity Generation Sources, Nigeria 2022



Source: International Energy Agency (2022)



Electricity generation from wind energy currently contributes a negligible fraction to Nigeria's total energy mix. The Katsina Wind Farm, with a proposed capacity of 10MW, represents the most significant onshore wind energy project in the country. Commissioned in 2012, it remains under construction, delaying its impact on the grid. Reasons for the delay include technical challenges, insecurity and poor financial management amongst a couple of others.

Smaller projects, such as the 5 kW/h Aero generator in Sayya Gidan-Gada, installed in 1988, and the 0.75 kW/h installation in Danjawa Village, have been operational for decades but provide only minimal power for localized use. The Energy Research Center in Benin also operates a 1 kW/h Aero generator, adding to research -driven efforts rather than significant energy output.

These pilot projects, though minimal in capacity, demonstrated the possibility of wind energy generation even in localized rural settings. They primarily served as testing grounds for renewable energy initiatives, contributing marginally to local electrification efforts. However, their small scale and off-grid nature meant their overall impact on Nigeria's energy landscape remained symbolic rather than substantive. This underscores the untapped potential of wind energy in the country, which requires greater investment, policy support, and infrastructure development to scale up.

Other notable projects like the Jaredi Wind Farm in Sokoto, with a planned capacity of 38MW, are still under construction. Larger projects, such as the proposed 30MW Kano Wind Farm, have been cancelled, due to similar problems with the other projects.

As a result of all these, wind energy contributes only marginally to Nigeria's electricity generation, highlighting the need for focused investments and policy reforms to harness its full potential.

S/N	Location	Year of Installation	Capacity	Current Status	Type
1	Sayya Gidan-Gada, Sokoto State.	1988	5KW/h	Active	Aero Generator
2	Dan-Jawa Village Sokoto State.	N/A	0.75KW/h	Active	Aero Generator
3	Energy Research Center, Benin	N/A	1KW/h	Active	Aero Generator
4	Katsina, Katsina State	2012	10MW	Under Construction	Onshore Wind Farm
5	Kano Wind Farm	NA	30MW	Cancelled	Onshore Wind Farm
6	Jaredi, Sokoto Wind Farm	2008	38MW	Under Construction	Onshore Wind Farm

Source: Global Energy Monitor (2024)

Drivers of Wind Energy in Nigeria

Government Policies and Incentives

Nigeria's commitment to global climate action and its ambition to diversify its energy mix are key drivers behind wind energy projects in the country. The Electric Power Sector Reform Act of 2005 laid the groundwork for private sector participation in electricity generation, creating a regulatory framework that includes renewable energy.

Additionally, Nigeria's ratification of the Paris Agreement in 2016 and subsequent submission of its Nationally Determined Contributions (NDCs) in 2017 underscored the country's pledge to reduce greenhouse gas emissions. These commitments have spurred investment in low-carbon technologies, including wind energy, as part of Nigeria's strategy to meet its international obligations.

Domestically, policy initiatives such as the Renewable Energy Master Plan (REMP) and the Climate Change Act of 2021 have further accelerated the development of wind energy. The REMP outlines specific targets for renewable energy adoption, aiming to achieve a 23% share by 2025, with wind power as a critical component.

The government's Renewable Energy Master Plan was launched in 2011 and was aimed at increasing the share of renewable energy to at least 13% by 2015, 23% by 2025, and 36% by 2030. The energy target will be comprised of renewable and carbon-intensive sources:

- Coal (2,200MW)
- The Nigerian National Integrated Power Project (NIPP) (1,896MW)
- Independent power projects (IPPs) (296 MW)
- Legacy assets (thermal (5600MW), hydro (1300MW) and wind (10MW)

The Climate Change Act institutionalizes climate governance, requiring the government to develop pathways toward net-zero emissions by 2060. These frameworks not only provide a roadmap for renewable energy deployment but also attract international support and funding, as demonstrated by partnerships with institutions like the African Development Bank and commitments from global entities such as the U.S.-EXIM Bank.

Nigeria's recent Energy Transition Plan (2022) and the passage of the Nigerian Electricity Act in 2023 mark significant milestones in advancing the renewable energy agenda. These initiatives prioritize sustainable energy projects, with wind energy recognized for its role in off-grid electrification and regional development, particularly in the northern and coastal areas. The country's carbon neutrality goal by 2060 emphasizes the need for scaling renewable technologies, making wind energy a viable solution to bridge Nigeria's energy deficit while aligning with global sustainability goals. These drivers collectively signal a strong commitment to integrating wind energy into Nigeria's energy future, leveraging policy, technology, and international collaboration.

Economic Drivers

The escalating price of diesel and fuel for generators has created a significant financial burden for businesses and households in Nigeria. Diesel generators, often relied upon due to inconsistent grid electricity, are becoming less economically viable as global and local fuel prices soar with fuel price reaching N1,060/litre as at Oct 2024 and local supply chains facing disruptions. This challenge is compounded by the high maintenance costs of these generators, making their long-term usage unsustainable for many. As these costs rise, alternative energy sources, particularly wind power, become increasingly attractive. Wind energy poses to offer a sustainable and cost-effective solution to Nigeria's energy crisis, especially in regions where wind speeds are sufficient for generation. With lower operational costs after installation, wind turbines present an economically viable alternative to diesel-dependent systems.

Additionally, the inefficiencies and unreliability of Nigeria's grid infrastructure, coupled with rising electricity tariffs, further enhance the competitiveness of renewable energy solutions. The dilapidated state of the grid means frequent power outages, forcing consumers to seek stable alternatives to meet their energy needs. Rising tariffs, driven by inflation and efforts to reform the electricity sector, add to the financial strain on consumers. Wind energy offers a decentralized and scalable solution that can reduce dependence on the grid while providing cost stability. In the long term, investing in wind energy infrastructure could lead to significant savings for consumers and businesses, making it a critical driver for adoption in Nigeria's evolving energy landscape.

Economic incentives and international collaborations further bolster the wind energy sector. Projects like the 10 MW Katsina Wind Farm highlight both the potential and challenges of deploying wind power in the country. However, the sector's progress also benefits from broader renewable energy investments, such as the recent $2.2 billion solar energy contract announced in 2023. While focused on solar, such large-scale investments indicate growing international confidence in Nigeria's renewable energy landscape. This creates a more favourable environment for wind energy, offering lessons in financing, policy alignment, and project scalability critical for the wind sector's growth.

Technological Progress

A recognition of the need for innovations, locally engineered and tailored to the wind profiles in Nigeria is a facet of addressing the country's wind energy challenges, particularly in regions with unpredictable wind patterns. One such advancement is the development of the AirVolt turbine by a team from Ahmadu Bello University, Zaria. Unlike conventional horizontal-axis turbines that require alignment with the wind direction, the AirVolt employs vertical-axis technology, allowing it to capture wind energy from any direction.

This design enhances stability and efficiency in areas with low or variable wind speeds, are easier to install and maintain, reducing costs and increasing accessibility for local communities and smaller-scale projects.

Source: Wind turbines target power shortages in rural Nigeria, (2024)

Challenges

Wind energy development in Nigeria faces a myriad of challenges ranging from economic, to financial to regulatory and more.

High Initial Capital Costs: The development and installation of wind energy projects require significant upfront investment, including costs for turbines, land acquisition, and infrastructure. For a country like Nigeria, where access to financing for renewable energy projects is limited, this poses a substantial barrier. Many investors and developers struggle to secure funding due to high interest rates, lack of incentives, and perceived risks in the renewable energy sector.

Access to Financing: Renewable energy projects, including wind energy, often rely on international financing. Nigeria's perceived political and economic risks make it less attractive to international investors. Limited access to affordable financing options further hampers the development of wind energy projects, especially for small and medium-scale developers.

Inadequate Data and Research: Despite Nigeria's potential for wind energy, the availability of accurate, high-resolution wind resource data is limited. Many studies are outdated or based on sparse datasets, leading to uncertainty in project planning and resource assessment. This lack of detailed and recent studies hampers the ability to identify and develop optimal sites for wind energy generation.

Technical and Skills Deficiencies: The deployment and maintenance of wind energy systems require specialized expertise, which is currently lacking in Nigeria. The country's renewable energy workforce is underdeveloped, necessitating investments in education, training, and capacity building to ensure the effective operation of wind energy systems.

Infrastructure and Grid Challenges: Nigeria's electricity grid is plagued by inefficiencies, poor maintenance, and limited capacity, which complicates the integration of wind energy. The intermittent nature of wind power requires robust grid infrastructure and storage solutions to ensure stability and reliability. However, the existing grid is ill-equipped to handle these requirements, leading to potential energy losses and instability.

Economic and Fossil Fuel Dependence: Nigeria's heavy reliance on fossil fuels for both energy generation and revenue creates economic and political inertia against the transition to renewable energy. Subsidies for diesel and gasoline make renewable energy alternatives appear less competitive in the short term, despite their long-term economic and environmental benefits.

Policy and Regulatory Bottlenecks: Although Nigeria has introduced several renewable energy policies, such as the Renewable Energy Master Plan and Climate Change Act, there are still significant gaps in implementation and enforcement. Lengthy licensing processes, unclear regulatory frameworks, and inadequate incentives for renewable energy developers deter investment in the wind energy sector.

Land Use Conflicts and Community Resistance: Large-scale wind projects require significant land, which can lead to conflicts over land use. In rural or densely populated areas, competing demands for agricultural land or community opposition to wind farms due to perceived environmental or aesthetic concerns can delay or halt projects.

Nigeria Wind Outlook

The outlook for wind energy in Nigeria is promising, driven by a combination of growing energy demand, declining costs of renewable technologies, and the need to diversify the country's energy mix.

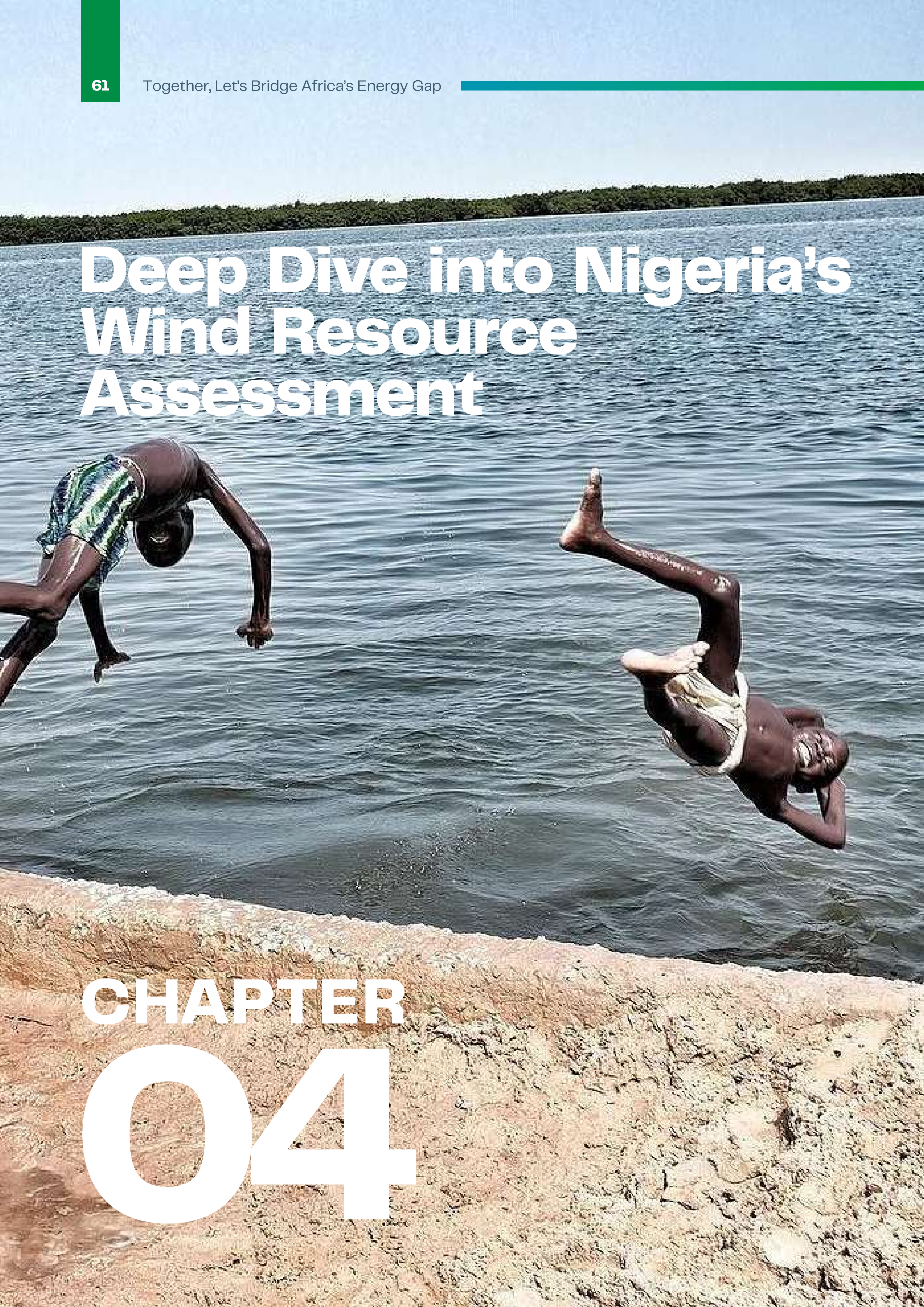
With significant untapped wind potential in regions such as the northern highlands and coastal areas, alongside government commitments like the Renewable Energy Master Plan and the Climate Change Act, the future of wind energy appears bright.

Advancements in localized turbine technologies, such as vertical-axis turbines, further enhance the feasibility of deploying wind power even in areas with moderate wind speeds. As grid infrastructure improves and financing options expand through international partnerships and green energy funds, wind energy could play a critical role in achieving Nigeria's carbon neutrality goal by 2060.

However, its growth will depend on addressing challenges such as infrastructure limitations, detailed wind resource mapping, and the integration of intermittent power sources into the national grid.

As grid infrastructure improves and financing options expand through international partnerships and green energy funds, wind energy could play a critical role in **achieving Nigeria's carbon neutrality goal by 2060.**

The future of Africa is tied to a just energy transition



Deep Dive into Nigeria's Wind Resource Assessment

CHAPTER

04

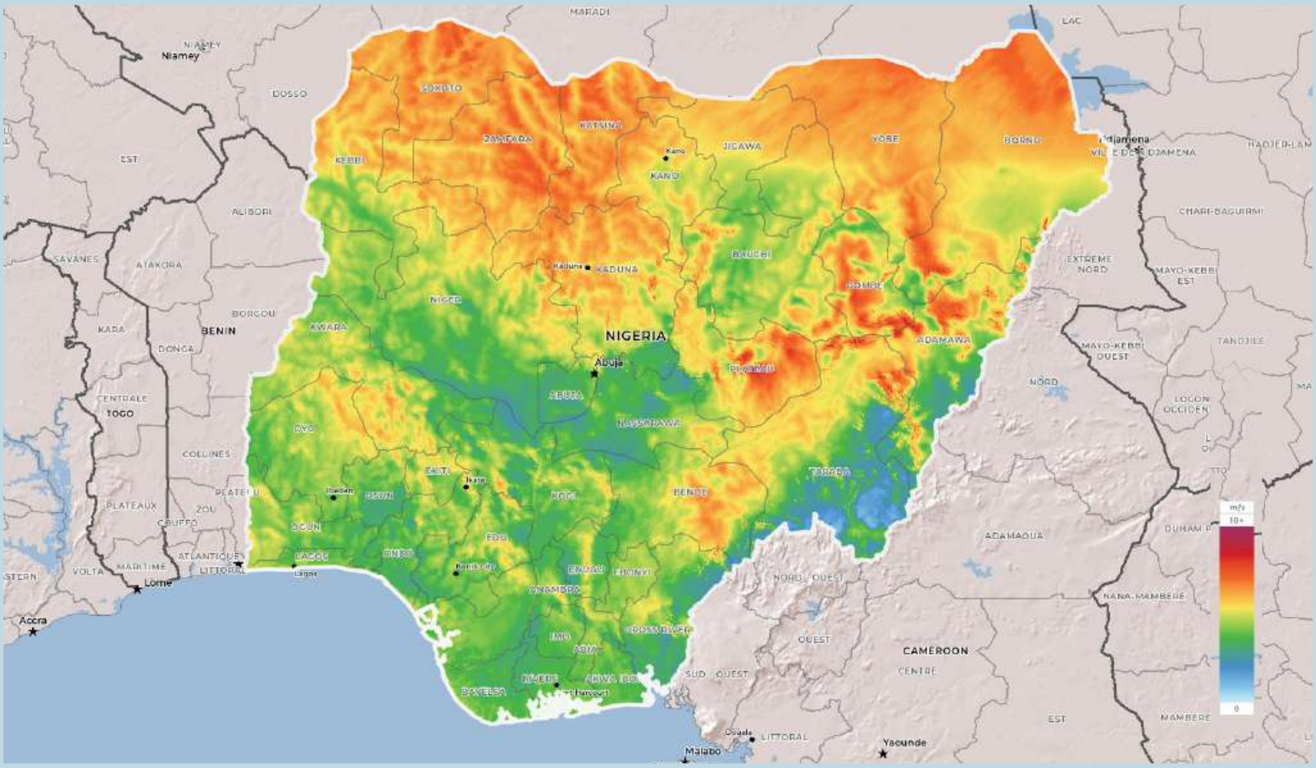
Introduction

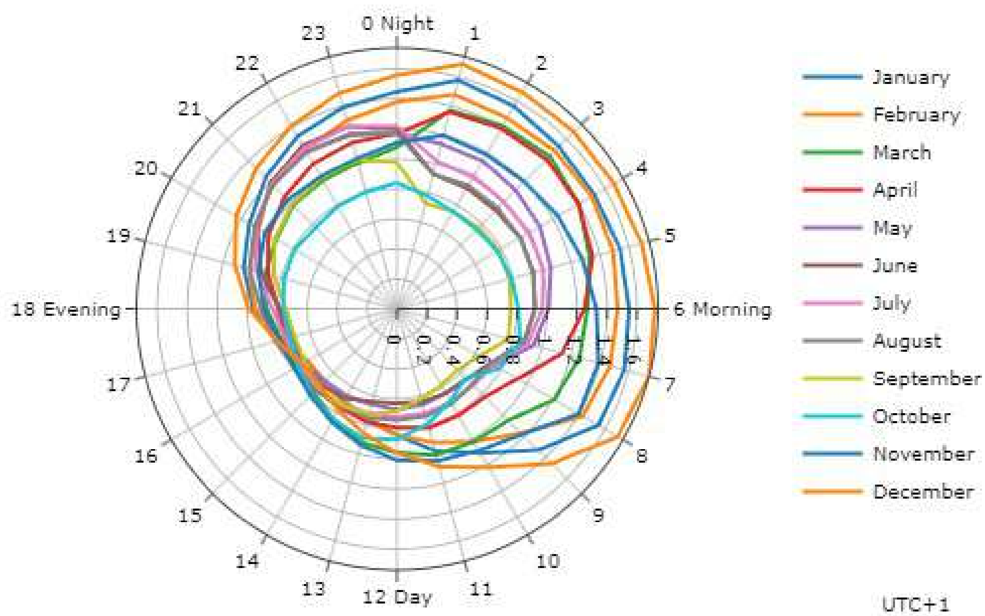
To fully grasp the potential and opportunities of wind energy in Nigeria, it is important to understand its resources and locations that are commercially viable. Wind speeds across Nigeria vary significantly by region, reflecting the diverse geographic and climatic conditions of the country. While studies like those by NIMET and the Global atlas show wind resources across the country there is a lack of comprehensive report on the wind energy potential and opportunities in Nigeria. More comprehensive and localized studies, additional wind measurement station and data management would be required to identify micro-level and commercially viable opportunities effectively.

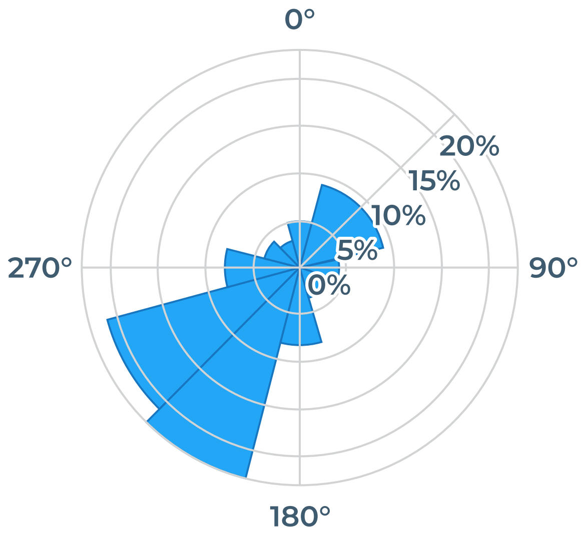
Previous reports on Nigeria's wind profile have stated that the stronger winds are to the North of the country. To the south, it is estimated that stronger winds can be found at higher altitude. Data from open-source databases (The Global Wind Atlas and Vortex), we have been able to establish that the average wind speed in Nigeria at 100m height is 6.79 m/s with a mean power density of 294 W/m². With 44.6% of the households in the country having no access to electricity, there exists a market gap to close.

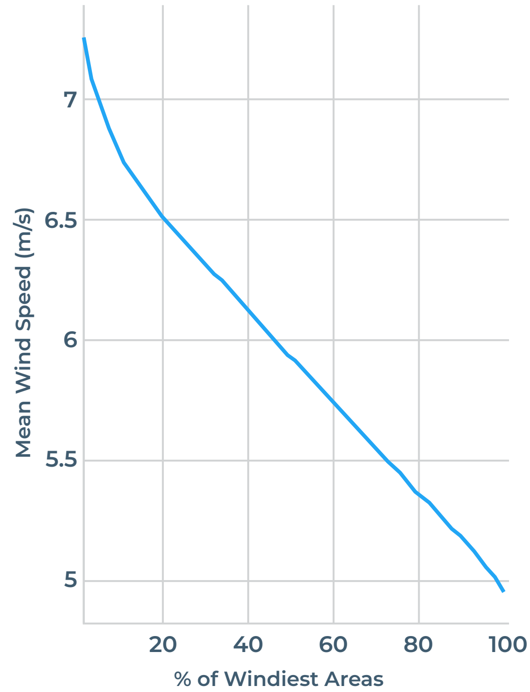
Nigeria's Wind Energy Summary

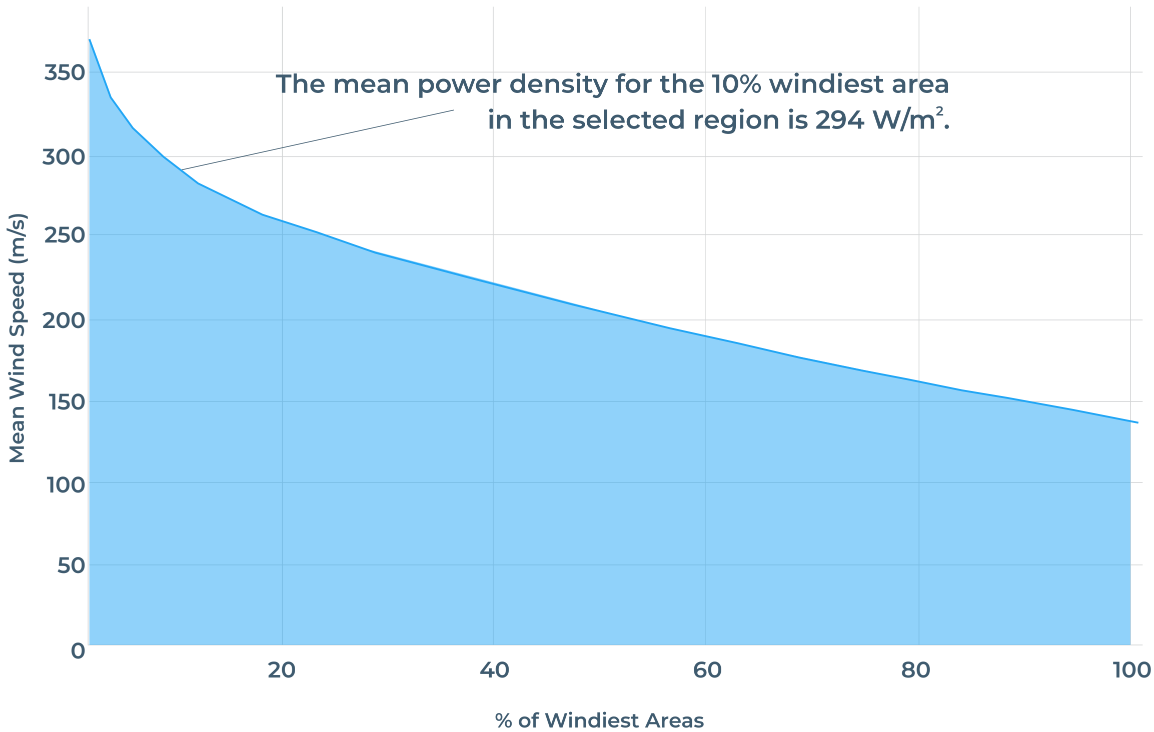
Nigeria's wind energy profile is summarized in the following graphs showing Nigeria's wind speed distribution at a height of 100m, seasonal variations, directional frequency, and the power density and mean wind speed of the country's top windiest regions.






0°
90°
180°
270°
0%
5%
10%
15%
20%


Mean Wind Speed (m/s)
7
6.5
6
5.5
5
20
40
60
80
100
% of Windiest Areas


The mean power density for the 10% windiest area
in the selected region is 294 W/m².
Mean Wind Speed (m/s)
350
300
250
200
150
100
50
0
20
40
60
80
100
% of Windiest Areas

South–West Region

South-West Region

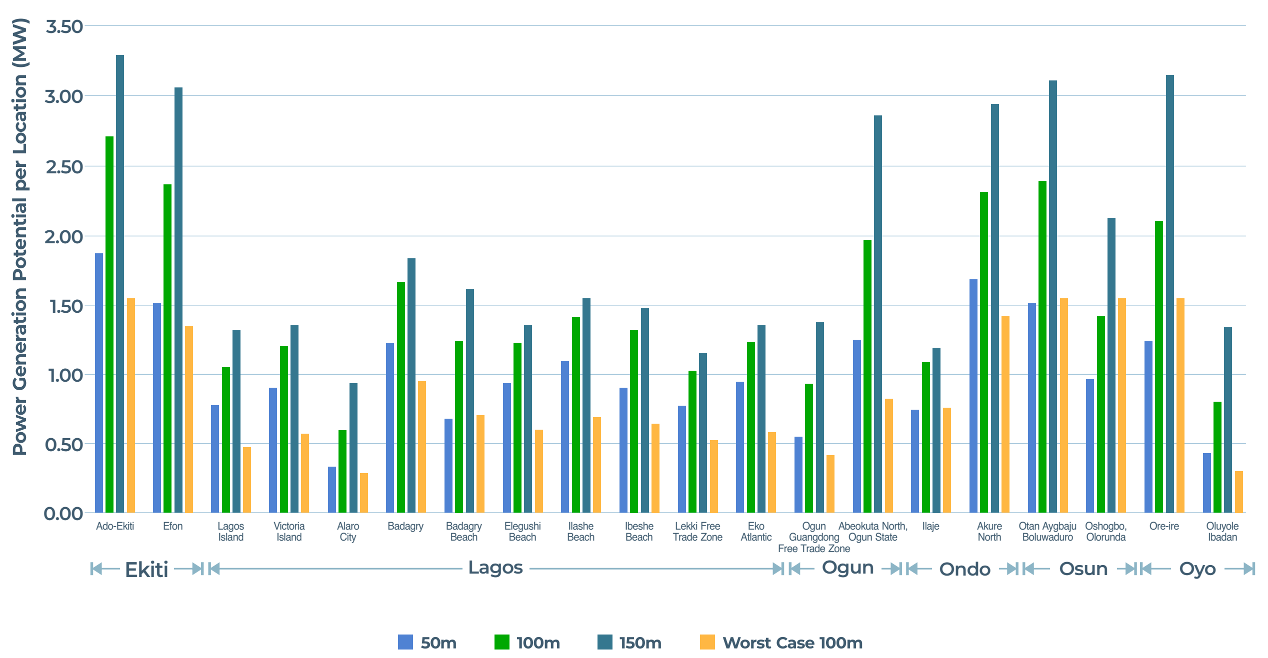
States: Ekiti, Oyo, Osun, Lagos, Ogun, Ondo States

Summary: It is estimated that there are about 32.5 million people living in Nigeria's Southwest. Comprising of 6 states, the region is home to Lagos, the commercial nerve center of Nigeria and Africa's 9th largest economy in terms of Gross Domestic Product. According to the National Bureau of Statistics, 32.7% of the region has no access to electricity and even when available, supply is epileptic with grid power being available for an average of 8 hours per day. OCEL wishes to close this energy gap in both residential and commercial sectors by deploying eco-friendly, renewable energy solutions to drive development and improve quality of life.

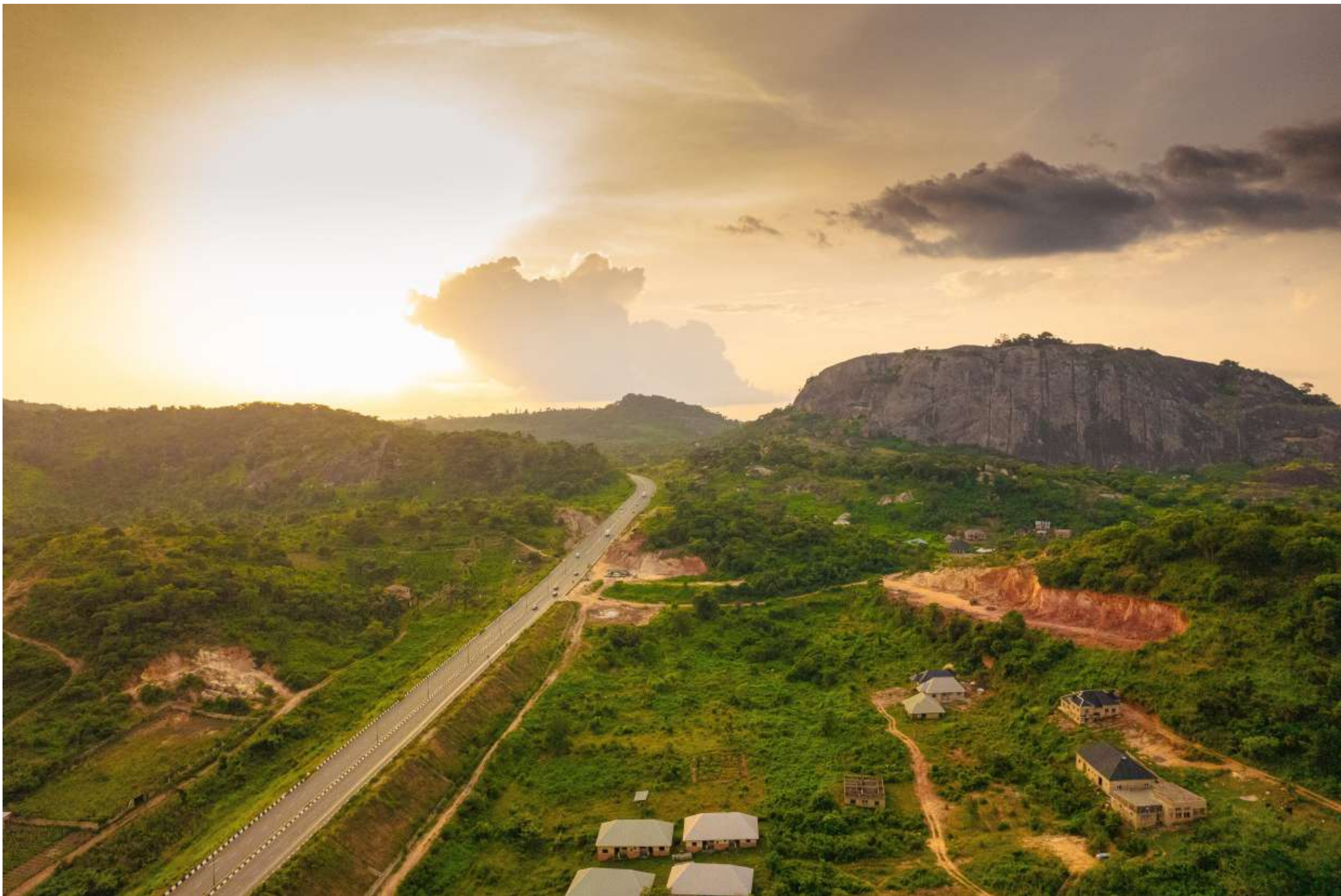
To do this, the company has commissioned a study of Nigeria's wind energy profile. 20 potential high wind areas have been selected across the 6 states, with Lagos having the highest share of 10 because of its superior commercial viability. The table below describes the locations looked at and the power generation potential at 50m, 100m and 150m heights, respectively. This study assumes that the default optimal height for the wind masts is 100m and a worst-case scenario at 100m is added for planning purposes.

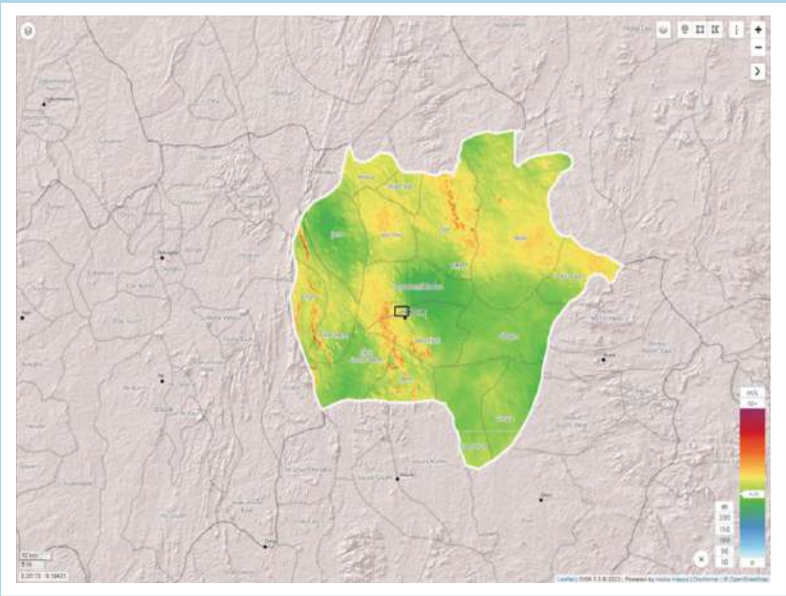
Wind Power Potential											
			50m		100m		150m		Worst Case Scenario		
State	Location	Coordinates	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Month
Ekiti	Ado-Ekiti	7.617081, 5.160484	5.77	1.86	6.53	2.70	6.97	3.28	5.42	1.54	October
	Efon	7.653831º, 4.930115º	5.38	1.51	6.24	2.36	6.80	3.05	5.18	1.35	December
Lagos	Lagos Island	6.533645º, 3.493652º	4.30	0.77	4.76	1.05	5.14	1.32	3.67	0.48	December
	Victoria Island	6.4281ºN, 3.4219ºE	4.53	0.90	4.98	1.20	5.18	1.35	3.88	0.57	December
	Alaro City	6.5598ºN, 3.9395ºE	3.27	0.34	3.94	0.59	4.58	0.93	3.11	0.29	December
	Badagry	6.409131º, 2.887255º	5.01	1.22	5.55	1.66	5.73	1.82	4.61	0.95	December
	Badagry Beach	6.4417ºN, 2.9776ºE	4.12	0.68	5.03	1.23	5.50	1.61	4.17	0.71	December
	Elegushi Beach	6.4221ºN, 3.4866ºE	4.58	0.93	5.02	1.23	5.19	1.36	3.97	0.60	December
	Ilashe Beach	6.4052ºN, 3.2049ºE	4.81	1.08	5.25	1.40	5.41	1.54	4.15	0.69	December
	Ibeshe Beach	6.427763º, 3.249806º	4.53	0.90	5.14	1.32	5.34	1.48	4.06	0.65	December
	Lekki Free Trade Zone	6.4362ºN, 3.9588ºE	4.30	0.77	4.72	1.02	4.91	1.15	3.78	0.52	December
	Eko Atlantic	6.412845º, 3.417759º	4.60	0.94	5.03	1.23	5.18	1.35	3.92	0.59	December
Ogun	Ogun Guandong Free Trade Zone	6.5556ºN, 3.1245ºE	3.85	0.55	4.57	0.93	5.22	1.38	3.53	0.42	December
	Abeokuta North, Ogun State	7.395153º, 3.02124º	5.04	1.24	5.87	1.96	6.65	2.85	4.40	0.83	December
Ondo	Ilaje	6.014922º, 4.899902º	4.25	0.74	4.81	1.08	4.97	1.19	4.28	0.76	May/October
	Akure North	7.363829º, 5.204773º	5.57	1.68	6.19	2.30	6.71	2,93	5.26	1.41	December
Osun	Otan Ayegbaju, Boluwaduro	7.931395º, 4.799221º	5.38	1.51	6.26	2.38	6.84	3.10	5.26	1.41	October
	Oshogbo, Olorunda	7.915224º, 4.547645º	4.64	0.97	5.25	1.40	6.02	2.12	4.20	0.72	December
Oyo	Ori-ire	8.393583º, 4.185791º	5.04	1.24	6.00	2.10	6.87	3.14	4.98	1.20	December
	Oluyole Ibadan	7.329703º, 3.909308º	3.54	0.43	4.34	0.79	5.17	1.34	3.16	0.31	December

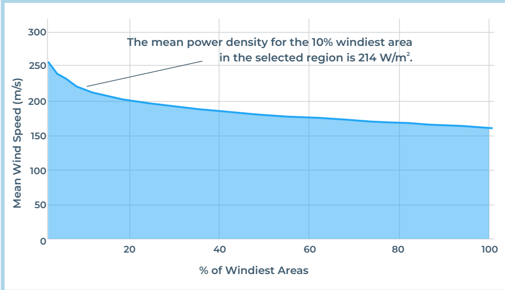
Power Generation Potential @ 50m, 100m and 150m Heights for South-West Nigeria

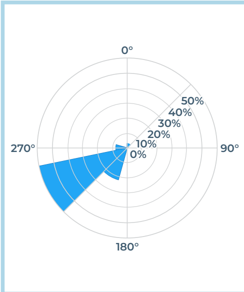


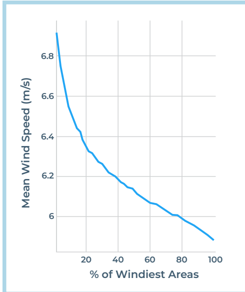
Ekiti State – Ado Ekiti: The landmass of capital of Ekiti State is 293km². It is home to a growing urban population engaged in both traditional and contemporary economic activities and it is located in southwest Nigeria on ancient plains composed mainly of basement rocks such as quartzite, granite, charnockite, and migmatite-gneiss Its undulating terrain features steep hills and dome-shaped inselbergs that significantly affect local wind patterns. Elevations range from 325m to 731m, with an average of about 430m.



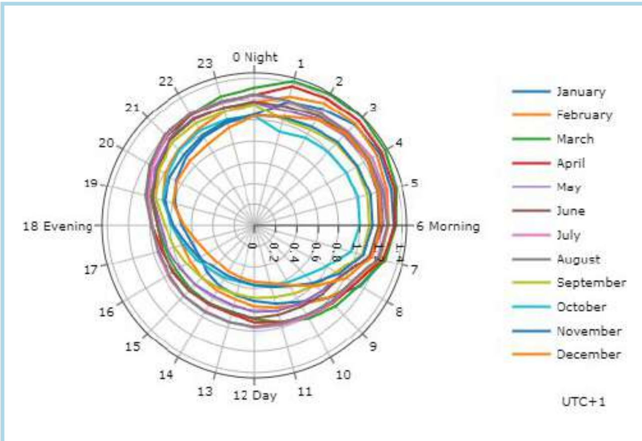








The wind rose diagram of our location in Ado Ekiti indicates the blowing predominantly from the Southwest direction at a mean wind speed of 6.53 m/s and mean power density of 214 W/m² at 10% of the windiest area.

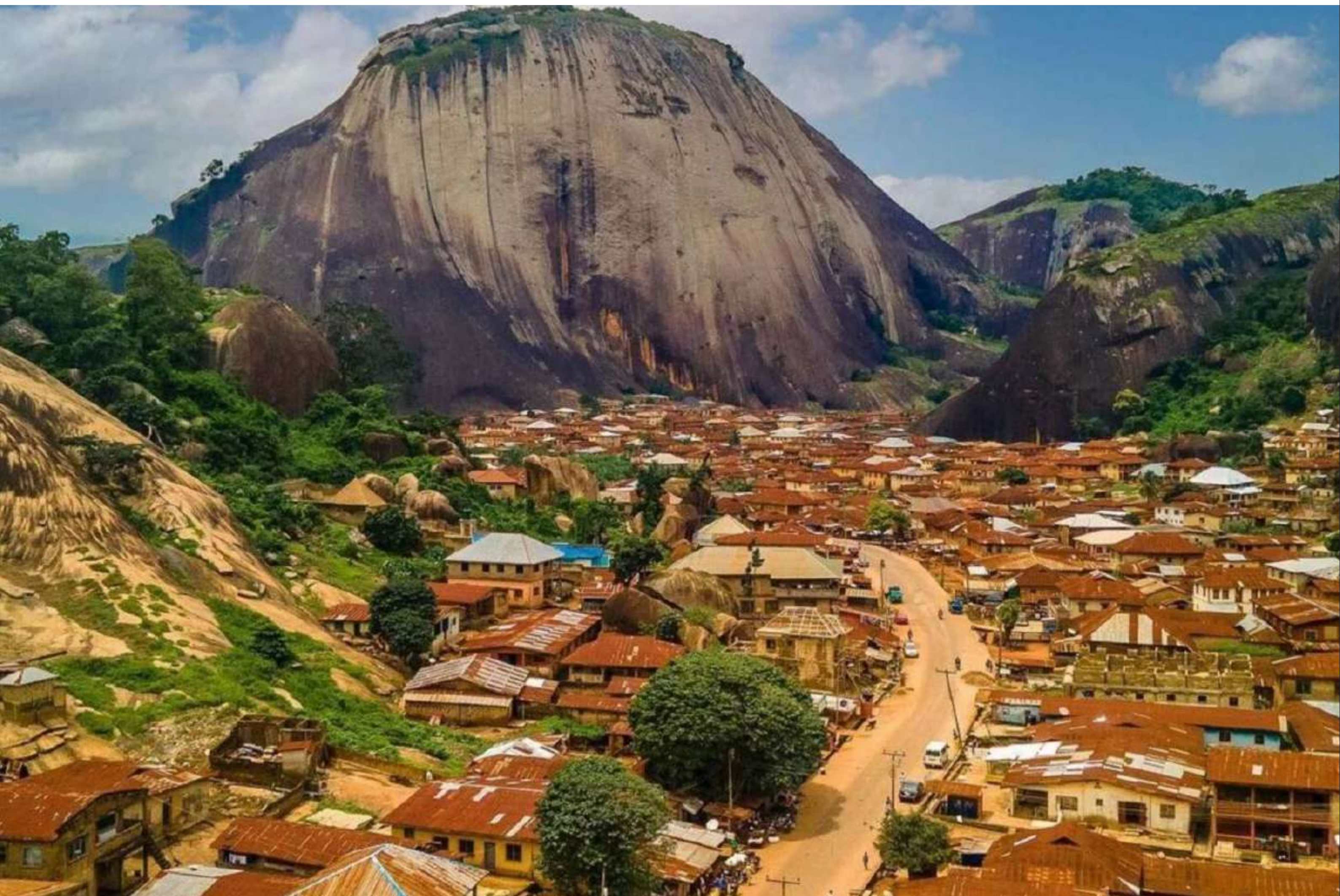


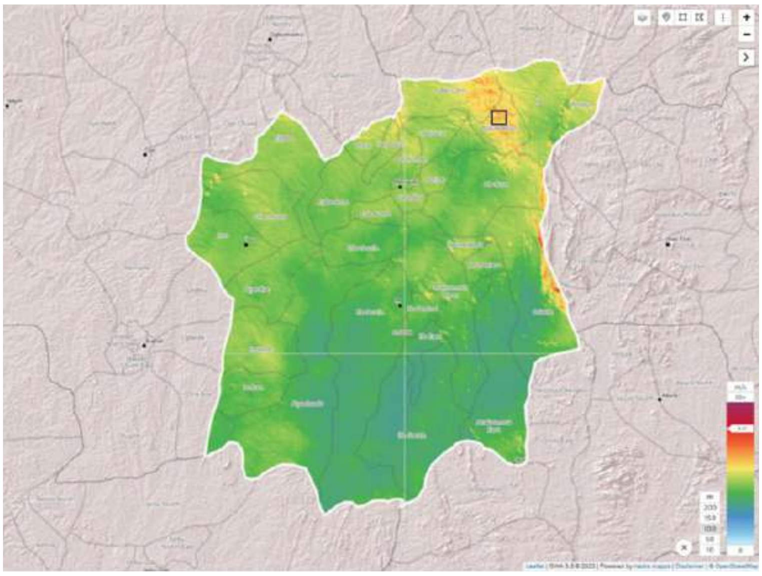
The wind speed in Ado Ekiti peaks in March and April at 7.44 m/s and is lowest in October at 5.49 m/s. The low case power generation capacity in this location is 2.41MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

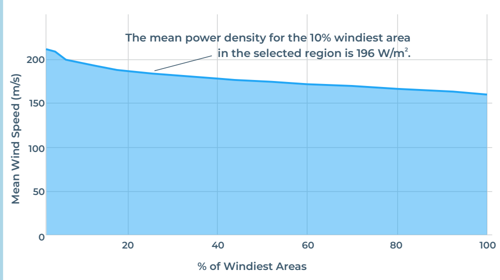
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
7.617081°, 5.160484°	Ekiti (South West)	Ado-Ekiti, Ekiti State	50m	5.77m/s	164W/m²
			100m	6.53m/s	214W/m²
			150m	6.97m/s	275W/m²

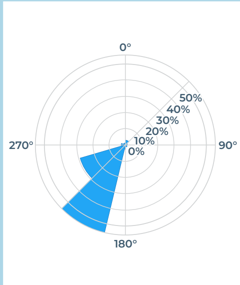
Osun State – Otan Ayegbaju: Otan Ayegbaju, located in Osun State, Nigeria, features a diverse topography characterized by rolling hills, rugged mountains, dense forests, and intricate gullies. The terrain is relatively rugged due to clusters of dome-shaped hills of varying sizes and orientations. Elevations in Osun State range from approximately 51m to 745m above sea level.

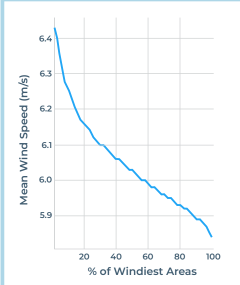
Hydrologically, Otan Ayegbaju is shaped by natural drainage through gullies and the moisture retained by dense forest cover. The combination of topographical features and vegetation modulates surface roughness and airflow, leading to localized variations in wind speed and direction.



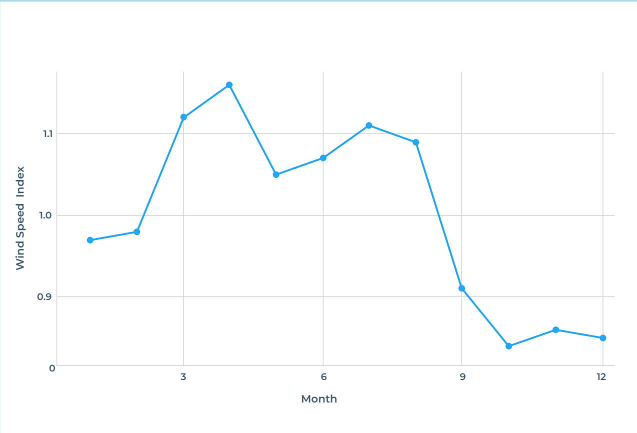


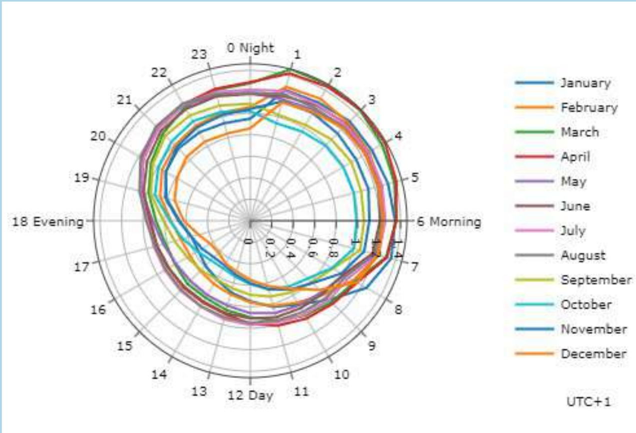






The wind rose diagram of Otan Ayegbaju, Boluwaduro suggests that the wind blows predominantly from the Southwest direction at a mean wind speed of 6.26 m/s and mean power density of 196 W/m² at 10% of the windiest area.



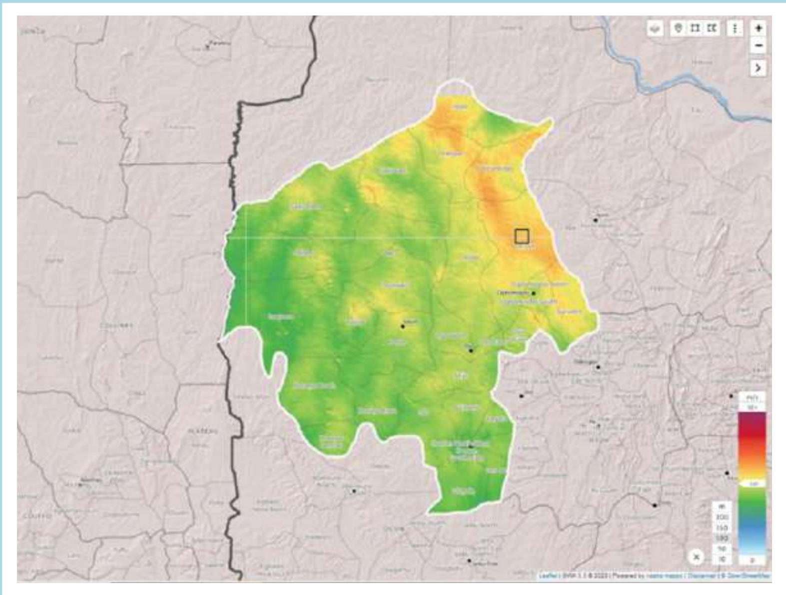


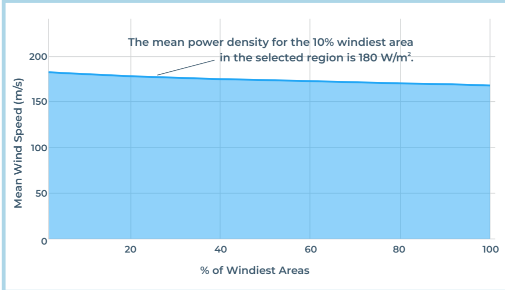
The wind speed in Boluwaduro peaks in April at 7.26 m/s and is lowest in October at 5.26 m/s. At peak period, we can generate up to 3.71MW with the low case power generation capacity at 1.41MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

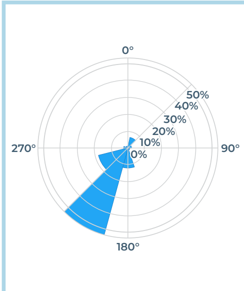
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
7.931395°, 4.799221°	Osun (South West)	Otan Ayegbaju, Boluwaduro, Osun State	50m	5.38m/s	140W/m²
			100m	6.26m/s	196W/m²
			150m	6.84m/s	263W/m²

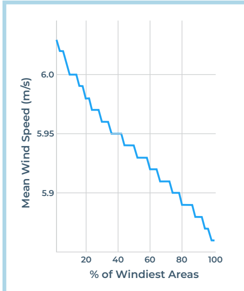
Oyo State – Ori Ire: This local government covers an area of 2,060km² and has an estimated population of approximately 213,500 people. It stretches from the Ipeba River along the Ogbomoso/ Oyo road to Dogo Junction near Igbeti, the headquarters of Olorunsogo Local Government Area.

The region features a hilly landscape with elevations reaching above 400m in some areas. Notable hills include Ila Hill at 398m, Ashuri Hill at 421m, Gbogun Hill at 371m, and Tengba Hill at 306m.

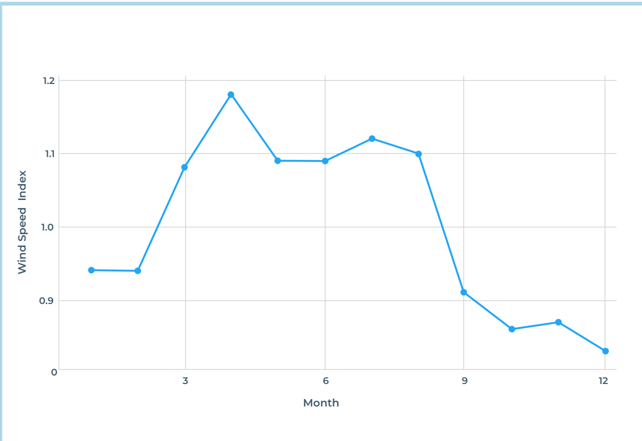


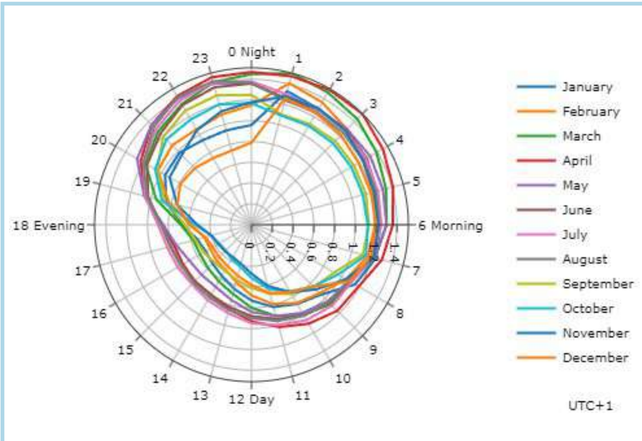






The wind rose diagram of Ori-Ire suggests that the wind blows predominantly from the Southwest direction at a mean wind speed of 6.00 m/s and mean power density of 180 W/m² at 10% of the windiest area.



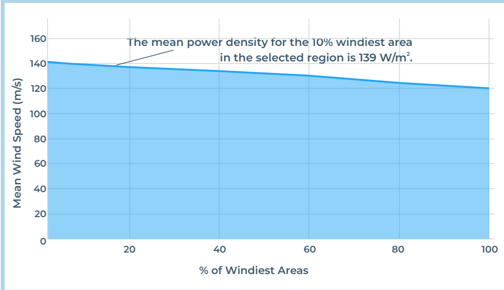


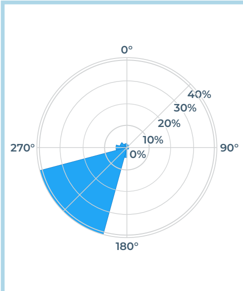
Ori-Ire's wind speed in peaks in April at 7.14 m/s and is lowest in December at 4.98 m/s. At peak period, we can generate up to 3.53MW with the low case power generation capacity at 1.20MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%. Average power generation capacity per turbine at this location is 2.10MW.

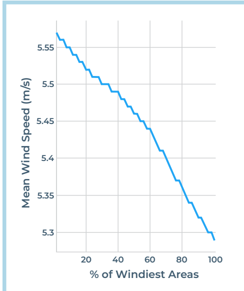
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
8.393583°, 4.185791°	Oyo (South West)	Ori-Ire, Oyo State	50m	5.04m/s	119W/m²
			100m	6.0m/s	180W/m²
			150m	6.87m/s	272W/m²

Lagos State – Badagry: A historic coastal town in Lagos State, Nigeria, is defined by its low-lying, flat topography, with elevations ranging from -4m to 55m. This unique coastal environment, closely linked to the Atlantic Ocean, plays a crucial role in shaping local wind dynamics and the town's distinct microclimate.

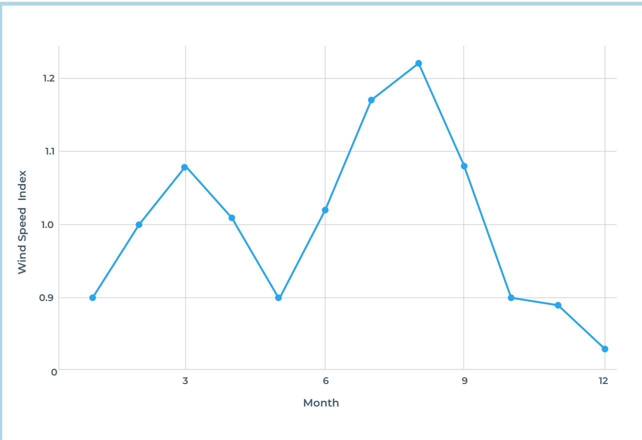
The region's hydrological characteristics are influenced by tidal interactions and the proximity of coastal water bodies, which govern moisture distribution and surface roughness. The flat terrain facilitates more consistent airflow, leading to stable wind patterns suitable for natural ventilation and urban planning.

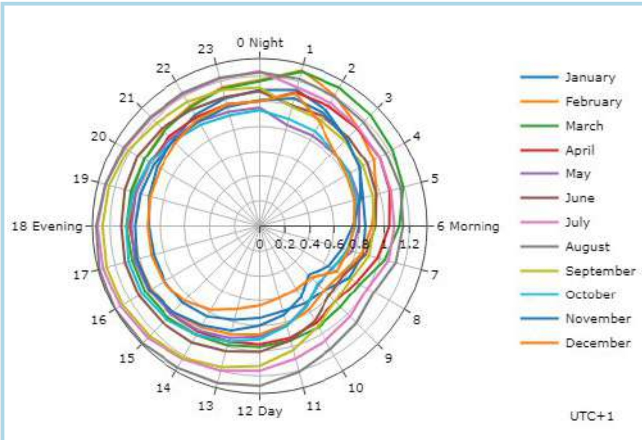






The wind rose diagram of Badagry indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.55 m/s and mean power density of 139 W/m² at 10% of the windiest area.

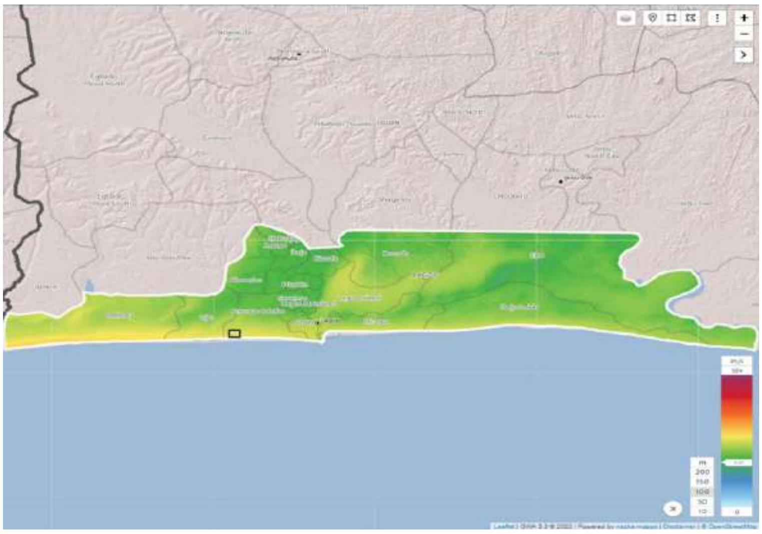


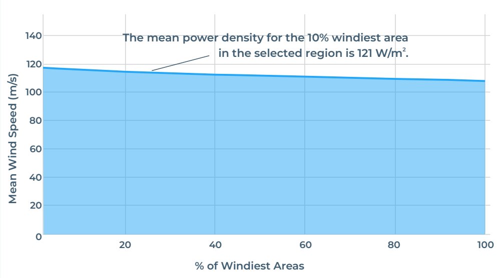


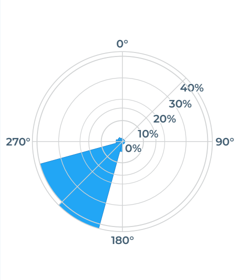
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.409°N, 2.8877°E	Lagos (South West)	Badagry, Lagos State	50m	5.01m/s	110W/m²
			100m	5.55m/s	139W/m²
			150m	5.73m/s	158W/m²

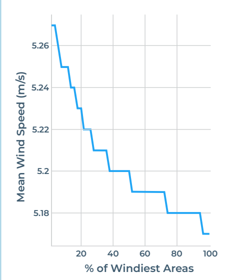
Lagos State – Ilashe: Located in Lagos State, is a picturesque island along the Lagos coast, positioned between Badagry Creek and the Atlantic Ocean. The island setting exposes it to strong maritime influences, which significantly shape local wind patterns and microclimate.

The hydrological dynamics of Ilashe are marked by tidal fluctuations from Badagry Creek and the open Atlantic, resulting in variable moisture levels and surface roughness. This coastal water-land interaction fosters distinctive wind behaviour.

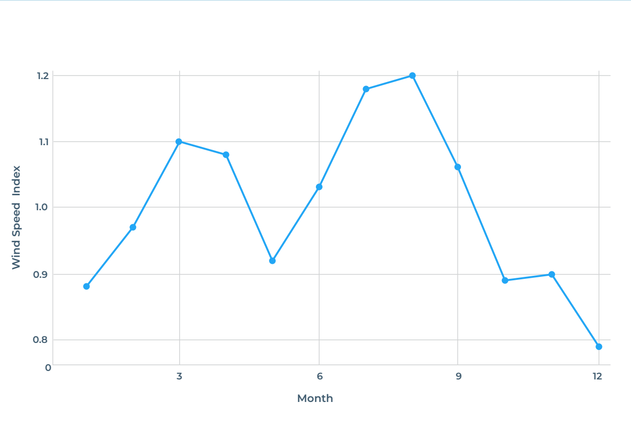


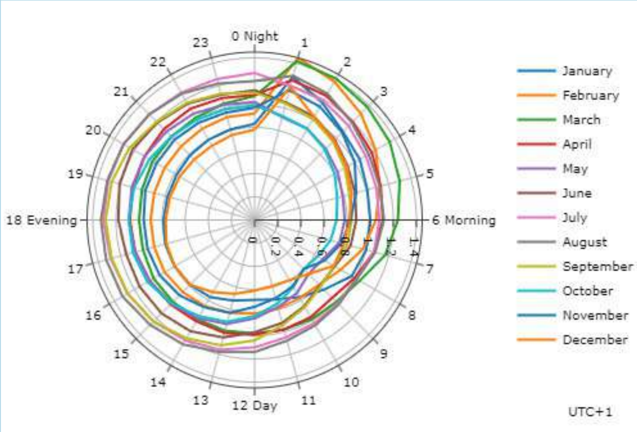






The wind rose diagram of Ilashe beach indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.25 m/s and mean power density of 121 W/m² at 10% of the windiest area.



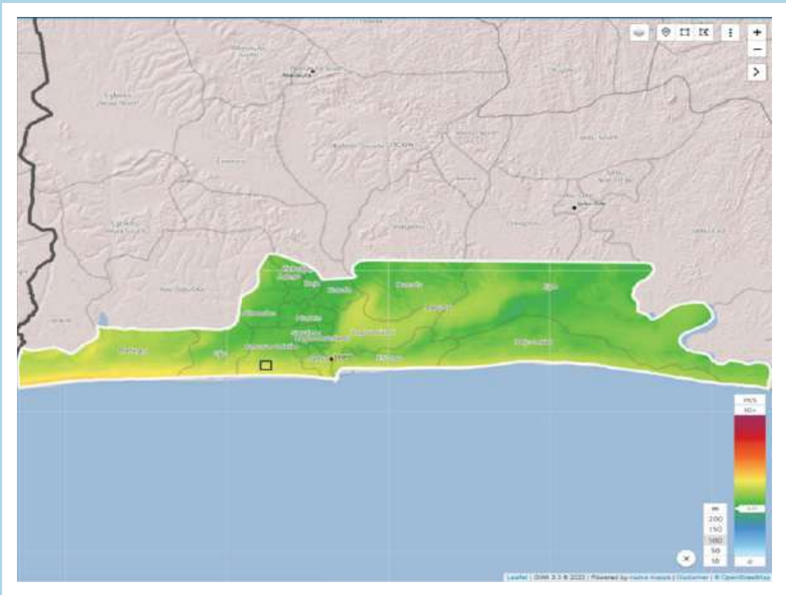


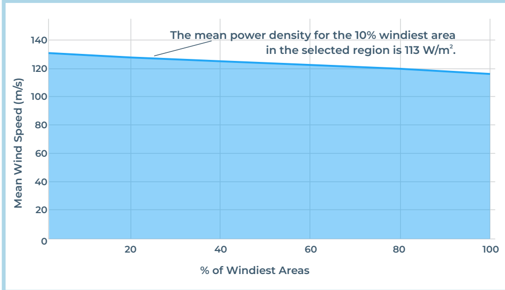
The wind speed at Ilashe beach peaks in August at 6.30 m/s and is lowest in December at 4.15 m/s. At peak period, we can generate up to 2.43MW with the worst-case generation capacity at 0.69MW, assuming we have 120m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%. Average power generation capacity per turbine at this location is 1.40MW.

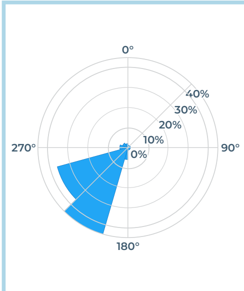
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.4052°N, 3.2049°E	Lagos (South West)	Ilashe beach, Lagos State	50m	4.81m/s	100W/m²
			100m	5.25m/s	121W/m²
			150m	5.41m/s	134W/m²

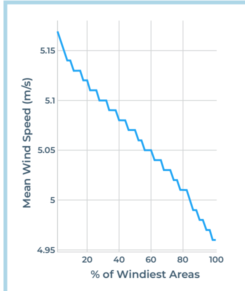
Lagos State – Ibeshe: Located in Lagos State, Nigeria, is a vibrant community nestled along the Lagos Lagoon. Lagos State features elevations ranging from -5m to 49m above sea level. This low-lying coastal environment plays a significant role in shaping local wind patterns and microclimatic conditions.

The proximity to the lagoon means that hydrological dynamics in Ibeshe are largely governed by tidal fluctuations and interactions between land and water.

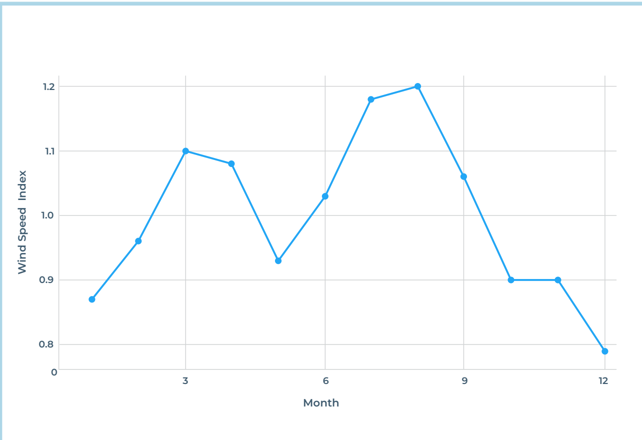


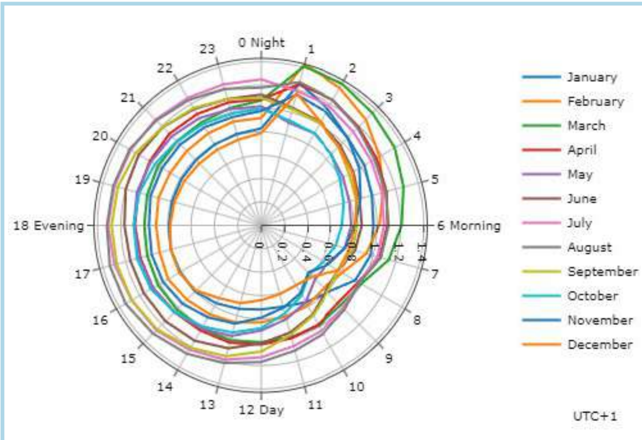






The wind rose diagram of Ibeshe indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.14 m/s and mean power density of 113 W/m² at 10% of the windiest area.



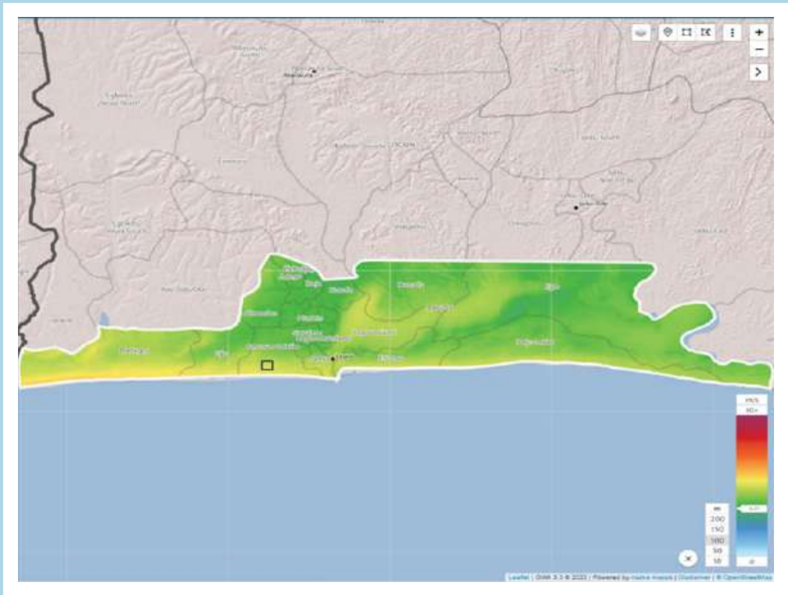


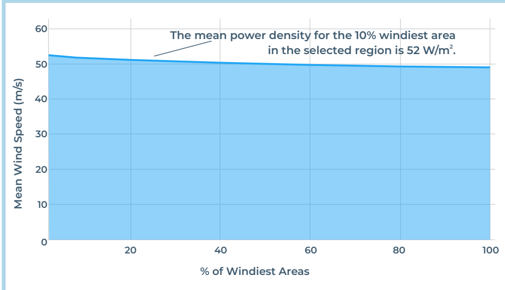
The wind speed at Ibeshe peaks in October at 6.17 m/s and is lowest in December at 4.06 m/s. At peak period, we can generate up to 2.28MW with the worst-case generation capacity at 0.65MW, assuming we have 120m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%. Average power generation capacity is 1.32MW.

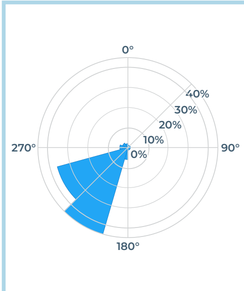
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.4281°N, 3.4219°E	Lagos (South West)	Ibeshe, Lagos State	50m	4.53m/s	86W/m²
			100m	4.96m/s	105W/m²
			150m	5.18m/s	119W/m²

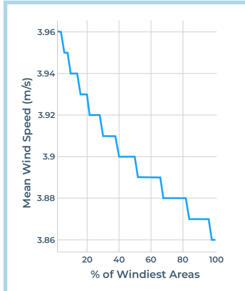
Lagos State – Alaro City: Located within Lagos State's Lekki Free Zone, is a pioneering integrated, mixed-use urban development that thoughtfully incorporates greenways aligned with prevailing winds and the natural topography. This innovative planning approach leverages local microclimatic conditions to enhance urban liveability and environmental sustainability.

The design of Alaro City capitalizes on the region's hydrological influences, including coastal moisture, tidal effects, and seasonal rainfall, which help shape ambient airflow.

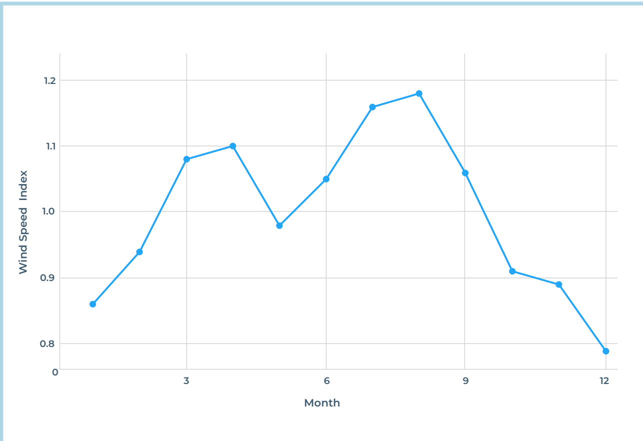


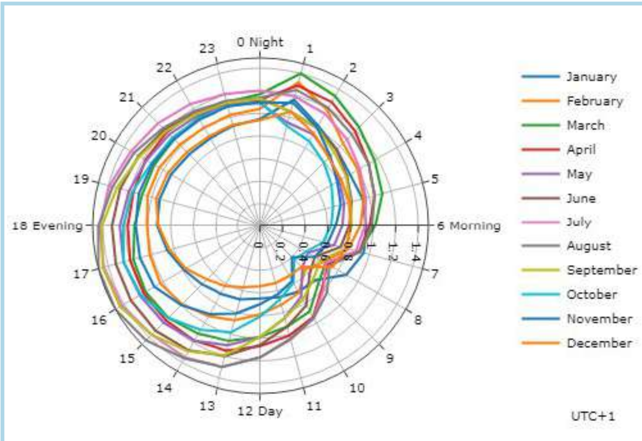






The wind rose diagram of Alaro City indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 3.94 m/s and mean power density of 52 W/m² at 10% of the windiest area. To commission wind energy projects here, higher masts, up to 150m should be considered or low-wind complaint power turbines, such as been deployed in Kenya.





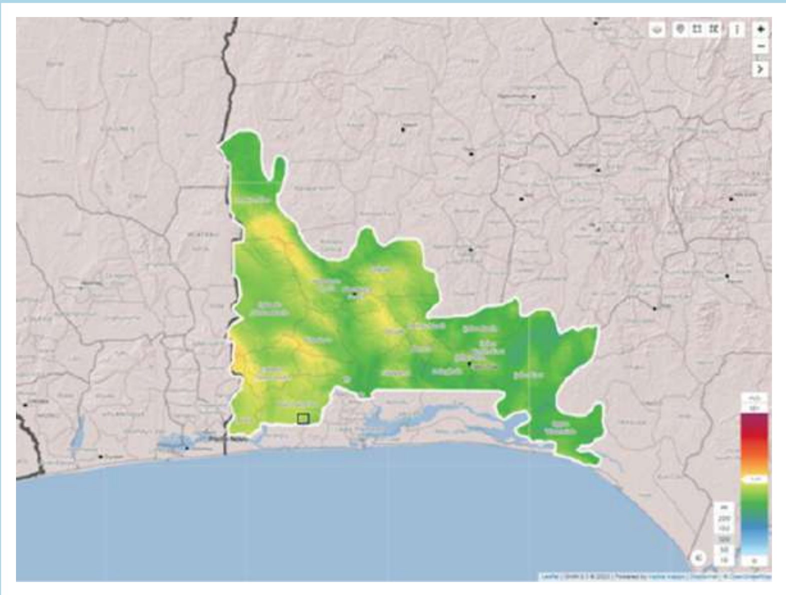
The wind speed at Alaro City peaks in August at 5.90 m/s and is lowest in December at 3.11 m/s. At peak period, we can generate up to 1.00MW with the worst-case generation capacity at 0.29MW, assuming we have 120m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

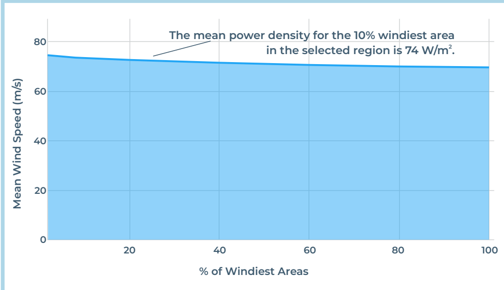
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.5598°N, 3.9395°E	Lagos (South West)	Alaro City, Lagos State	50m	3.27m/s	33W/m²
			100m	3.94m/s	52W/m²
			150m	4.58m/s	77W/m²

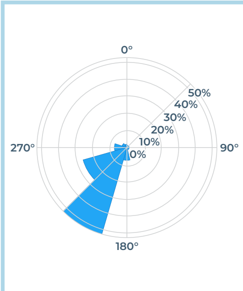
Ogun State–Guangdong Free Trade Zone: Also known as OGFTZ, this location spans approximately 100km², featuring a relatively flat terrain typical of the coastal plains in south-western Nigeria. This flat topography is conducive to industrial development and infrastructure expansion within the zone.

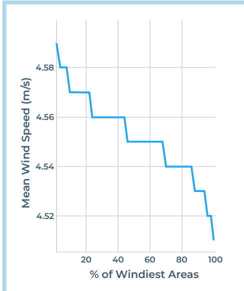
The landscape is distinctly industrial, characterized by manufacturing plants, warehouses, and administrative buildings.

OGFTZ experiences a tropical wet and dry climate, with average annual temperatures around 29.3°C.

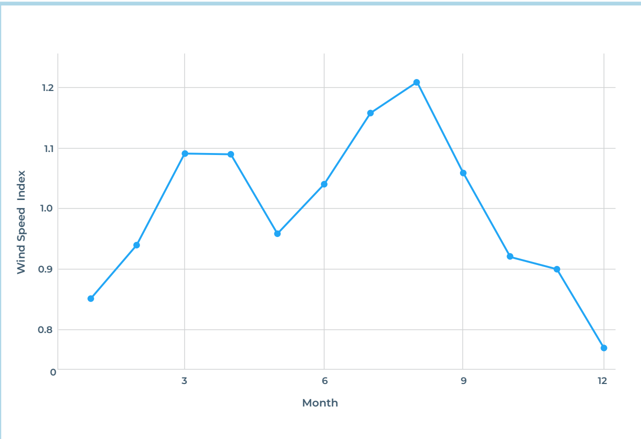


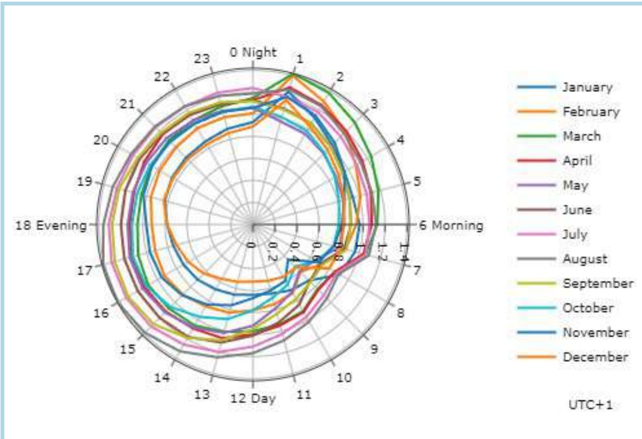






The wind rose diagram of the Ogun Guangdong Free Trade Zone in Ado Odo Ota local government indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 4.57 m/s and mean power density of 74 W/m² at 10% of the windiest area.



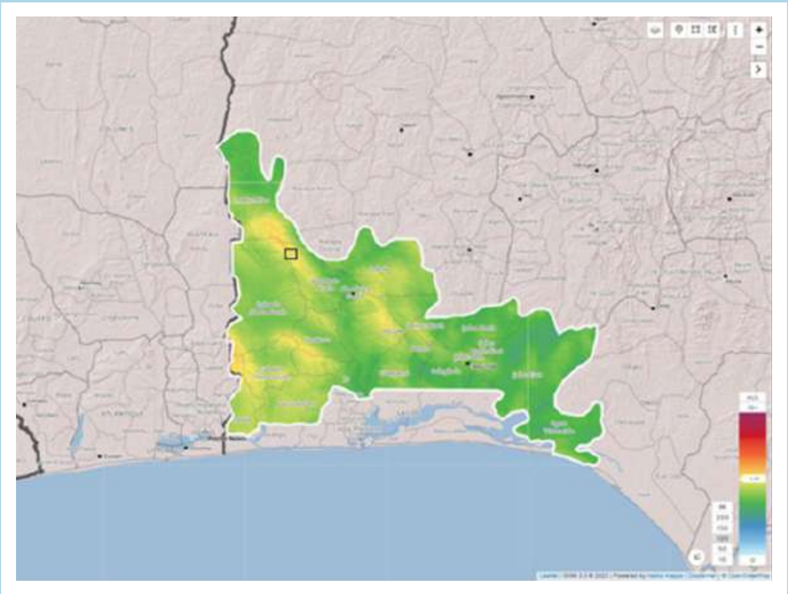


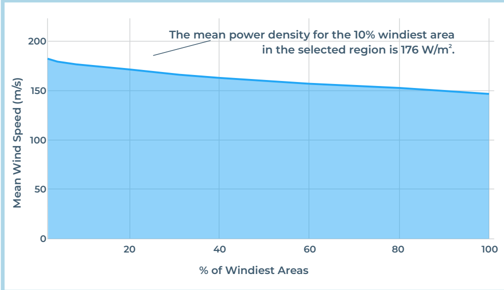
The wind speed in Ogun Guangdong Free Trade Zone peaks in August at 5.53 m/s and is lowest in December at 3.52 m/s. At peak period, we can generate up to 1.64MW with the worst-case generation capacity at 0.42MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%. Average capacity is 0.93MW

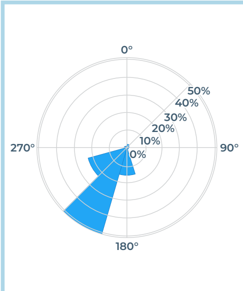
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.5556°N, 3.1245°E	Ogun (South West)	Ogun Guangdong Free Trade Zone, Ogun State	50m	3.85m/s	48W/m²
			100m	4.57m/s	74W/m²
			150m	5.22m/s	109W/m²

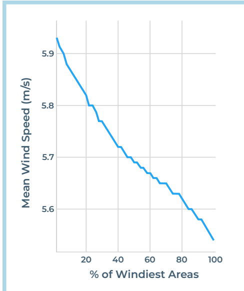
Ogun State – Abeokuta North: Abeokuta, the capital of Ogun State in south-western Nigeria, is situated on the east bank of the Ogun River. The city's name, meaning "Refuge Among Rocks" in Yoruba, reflects its historical significance as a sanctuary for the Egba people in the early 19th century.

The terrain of Abeokuta is undulating, with elevations ranging from approximately 12m to 219m above sea level. Prominent geological features, such as Olumo Rock-a granite outcrop rising about 137m above the surrounding area-are notable landmarks.

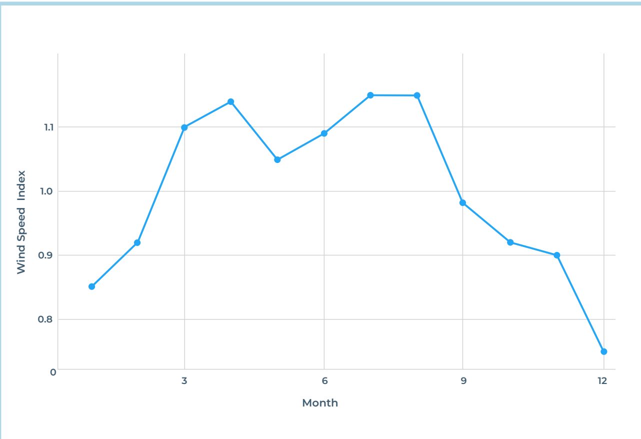


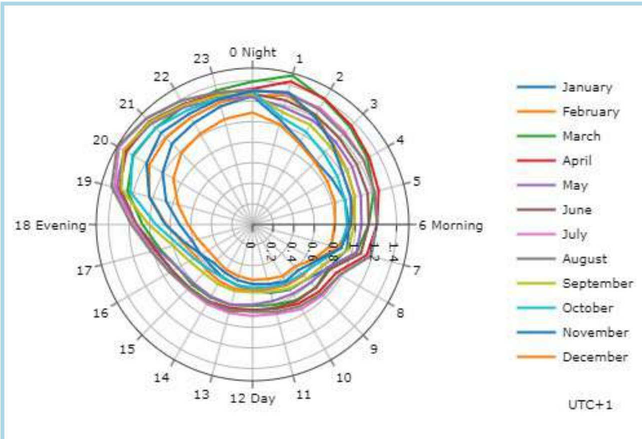






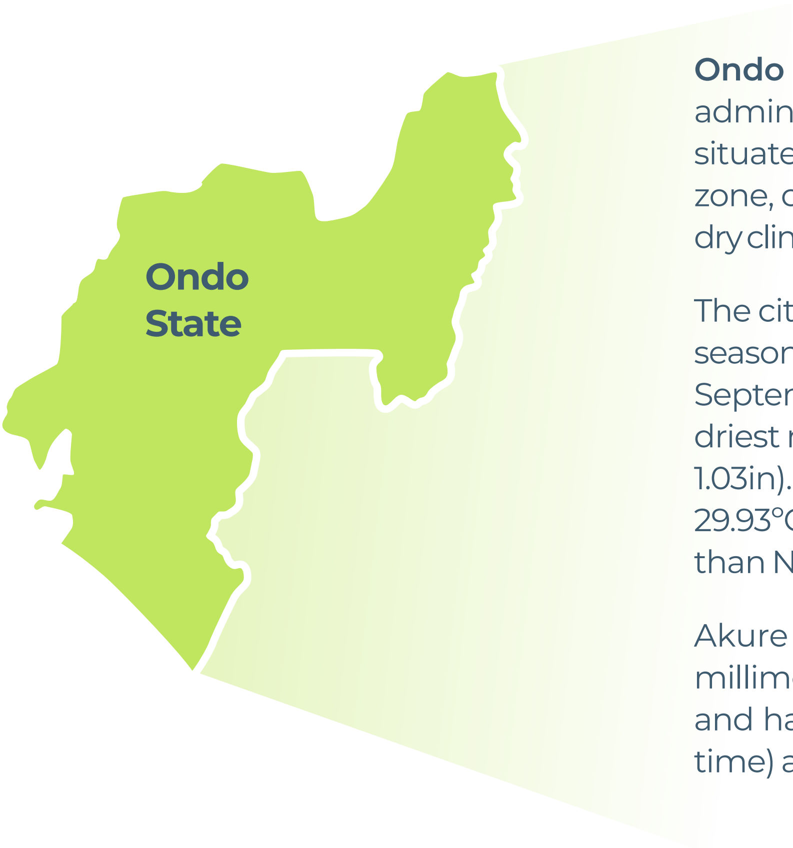
The wind rose diagram of the Abeokuta North area indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.87 m/s and mean power density of 176 W/m² at 10% of the windiest area.





The wind speed in Abeokuta peaks in July and August at 6.75 m/s and is lowest in December at 4.40 m/s. At peak period, we can generate up to 2.98MW with the worst-case generation capacity at 0.83MW, assuming we have 120m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%. Average power generation capacity is 1.96MW

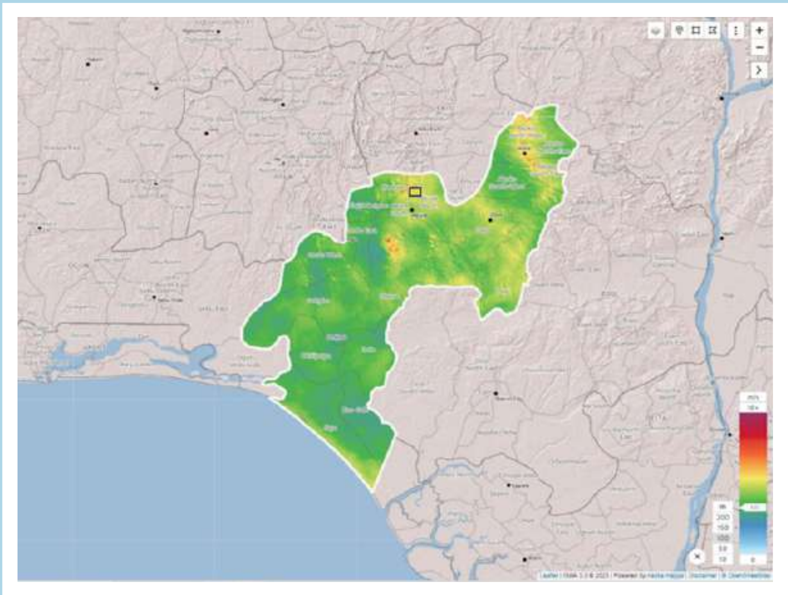
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
7.395153°N, 3.02124°E	Ogun (South West)	Abeokuta North, Ogun State	50m	5.04m/s	126W/m²
			100m	5.87m/s	174W/m²
			150m	6.65m/s	250W/m²

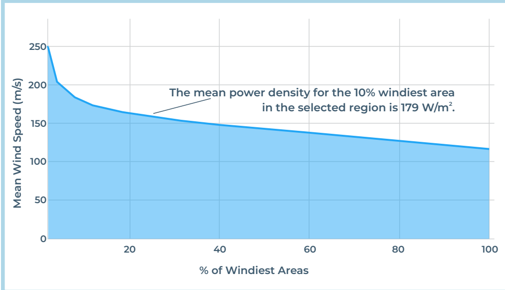


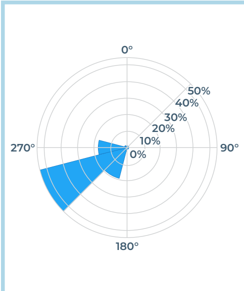
Ondo State – Akure North: It is the administrative capital of Ondo State, and situated within Nigeria's tropical humid zone, characterized by a tropical wet and dry climate (Köppen-Geiger classification).

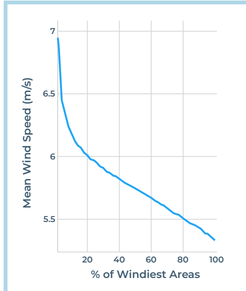
The city experiences distinct wet and dry seasons, with the wettest month being September (344.4mm/13.56in) and the driest month being December (26.1mm / 1.03in). The district's yearly temperature is 29.93°C (85.87°F) and it is 0.47% higher than Nigeria's averages.

Akure typically receives about 192.64 millimetres (7.58 inches) of precipitation and has 280.38 rainy days (76.82% of the time) annually.

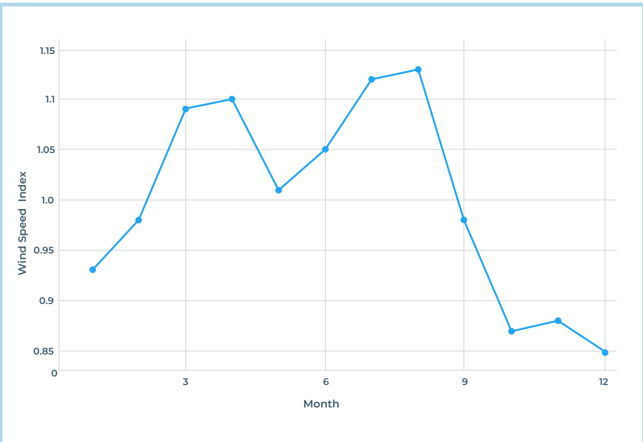


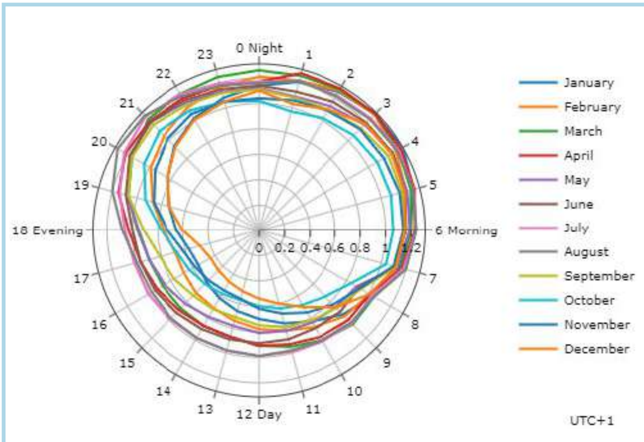






The wind rose diagram of the Akure North area indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 6.19 m/s and mean power density of 179 W/m² at 10% of the windiest area.



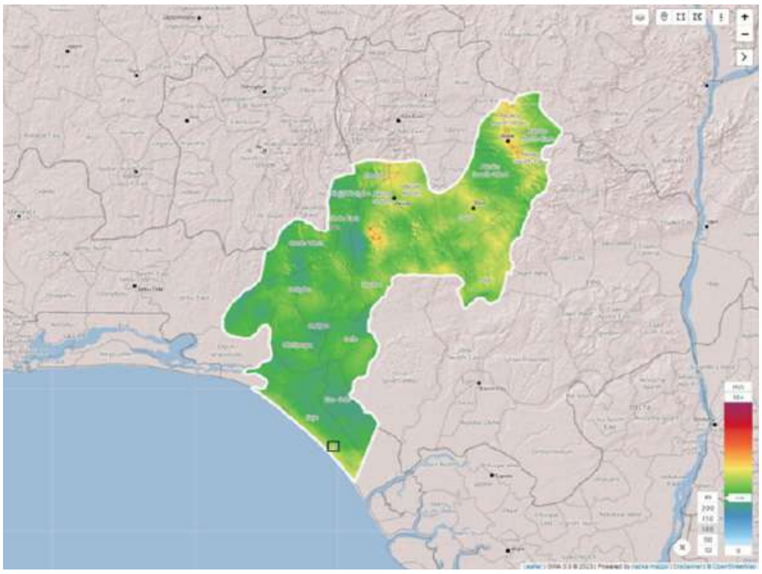


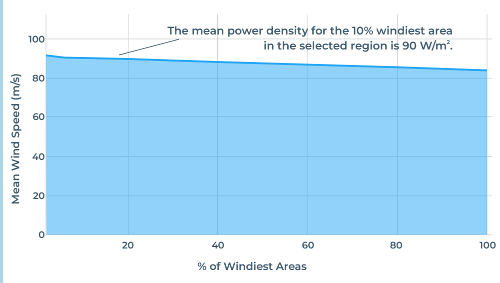
The wind speed in Akure North peaks in August at 6.99 m/s and is lowest in December at 5.26 m/s. At peak period, we can generate up to 3.31MW with the low case generation capacity at 1.41MW, assuming we have 120m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%. Average power generation capacity is 2.30MW

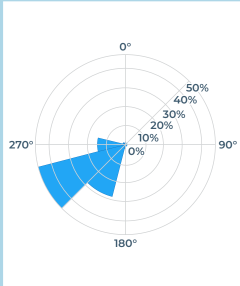
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
7.363829°, 5.204773°	Ondo (South West)	Akure North, Ondo State	50m	5.57m/s	145W/m²
			100m	6.19m/s	179W/m²
			150m	5.71m/s	231W/m²

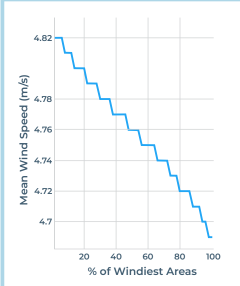
Ondo State – Ilaje: A coastal region in Ondo State, Nigeria, is characterized by its flat and low-lying topography, with elevations averaging around 3m above sea level. The area's proximity to the Atlantic Ocean significantly influences its climate, resulting in a humid environment with high annual rainfall.

Hydrologically, Ilaje is shaped by tidal effects and seasonal rainfall, which govern moisture distribution and surface characteristics, subtly modulating wind behaviour. The local economy is predominantly based on traditional fishing practices, as detailed in an economic analysis of artisanal fisheries in selected Ilaje communities.

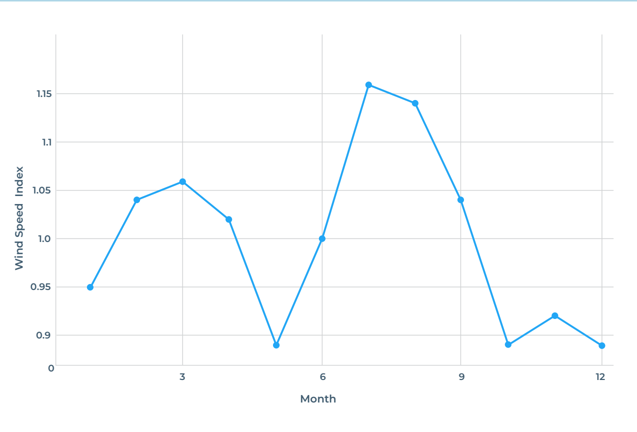


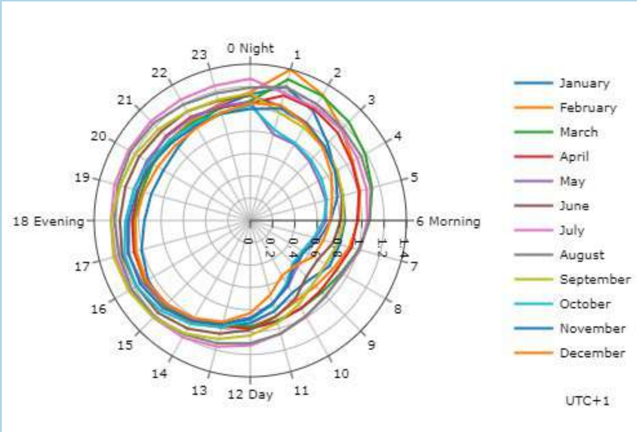






The wind rose diagram of the Ilaje area indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 4.81 m/s and mean power density of 90 W/m² at 10% of the windiest area.

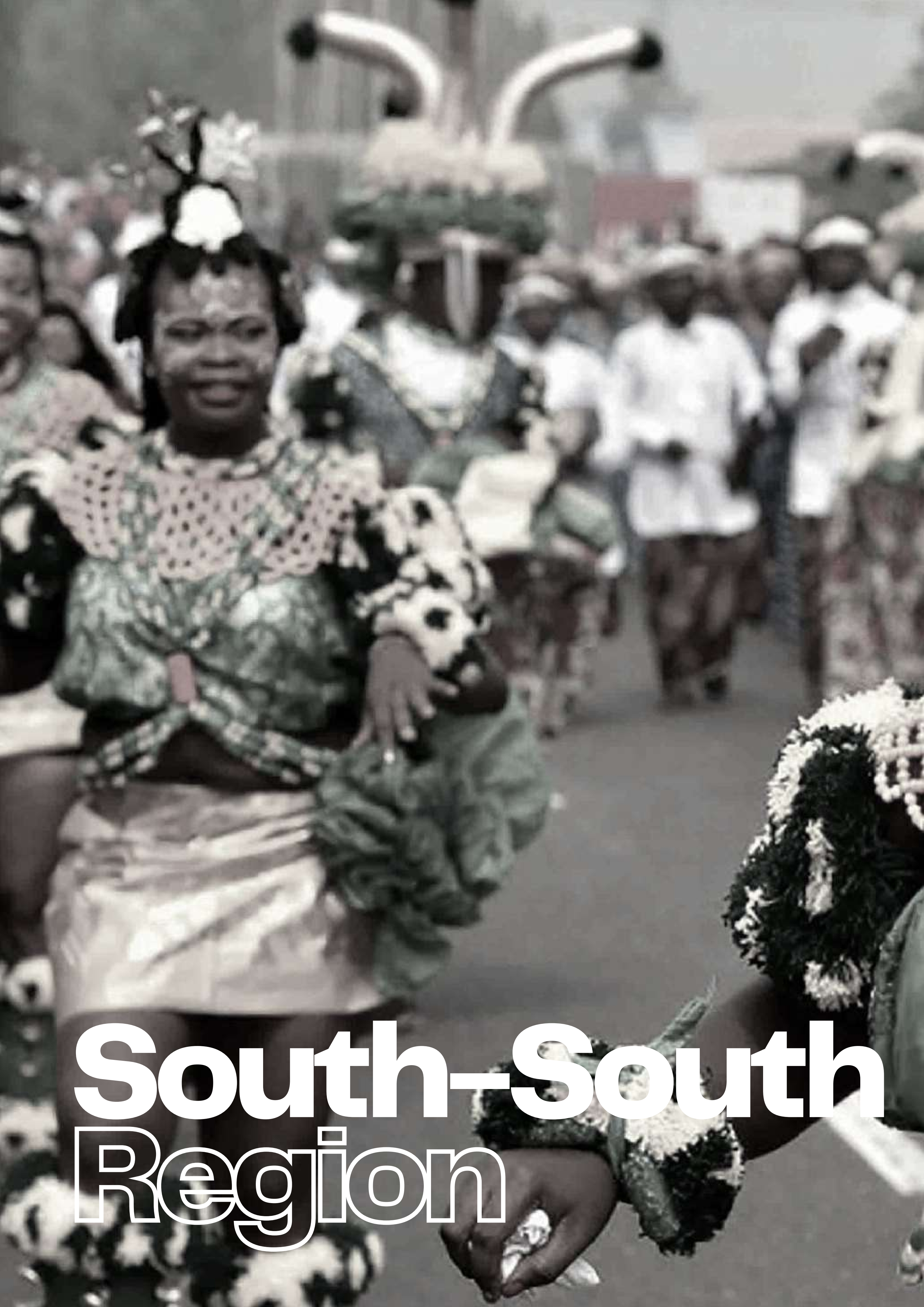




The wind speed in Ilaje peaks in July at 5.58 m/s and is lowest in May, October, and December at 4.38 m/s. At peak period, we can generate up to 1.69MW with the low case generation capacity at 0.76MW, assuming we have 120m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%. Average power generation capacity is 1.08MW

Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.014922°, 4.899902°	Ondo (South West)	Ilaje, Ondo State	50m	4.25m/s	67W/m²
			100m	4.81m/s	90W/m²
			150m	4.97m/s	102W/m²

National theatre, Iganmu, Lagos State



South–South Region

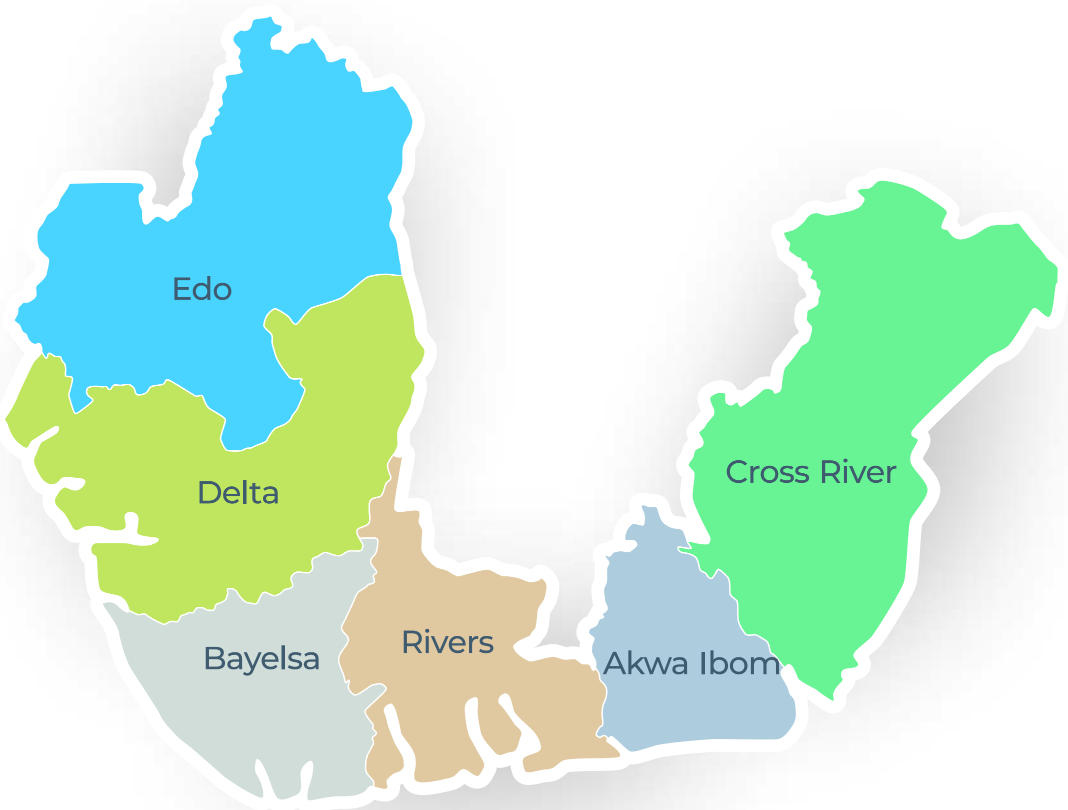
South-South Region

States: Akwa Ibom, Bayelsa, Cross River, Delta, Edo, and Rivers.

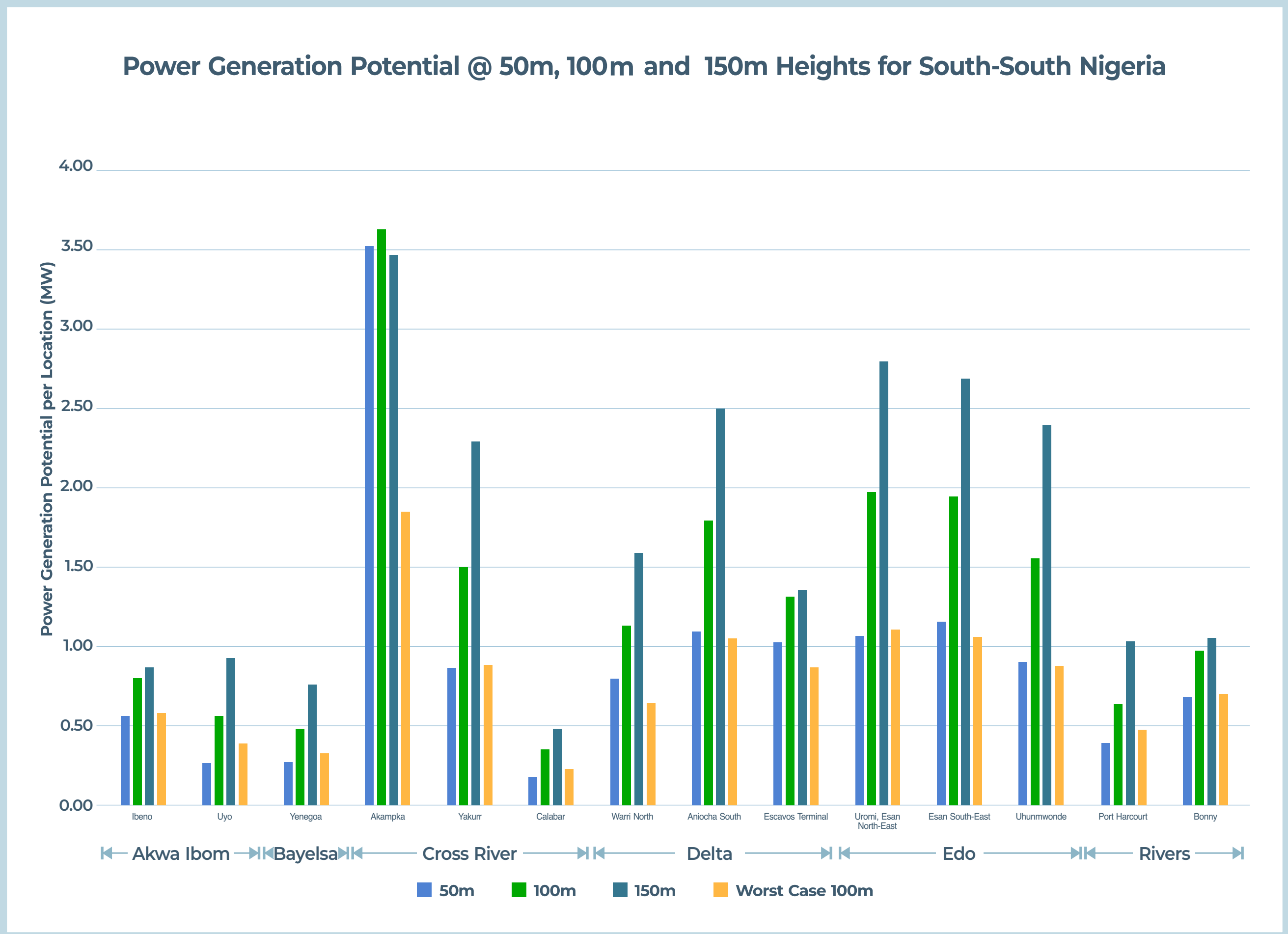
Summary: Strategic to the Nigerian economy, this region is host to the oil rich Niger Delta basin in Nigeria. It is home to about 26 million people with its largest cities largest cities being Port Harcourt and Benin City. Because of the activities of oil and gas companies, the region is plagued by gas flaring and prone to environmental pollution, both of which significantly contribute to increased carbon emission.

Despite the presence of the oil and gas companies, the region still has 27% of its populace without access to electricity. OCEL intends to drive the decarbonization agenda of the Federal Government by providing alternative clean energy solutions to drive the activities of the oil firms and for residential/other business uses.

Across the 6 states in the region, we have evaluated 12 locations with a location in Cross River (Akamkpa) ranking highest in terms of power generating capacity from wind. Edo State (Uromi, Esan North-East and South-East) also has good wind potential.

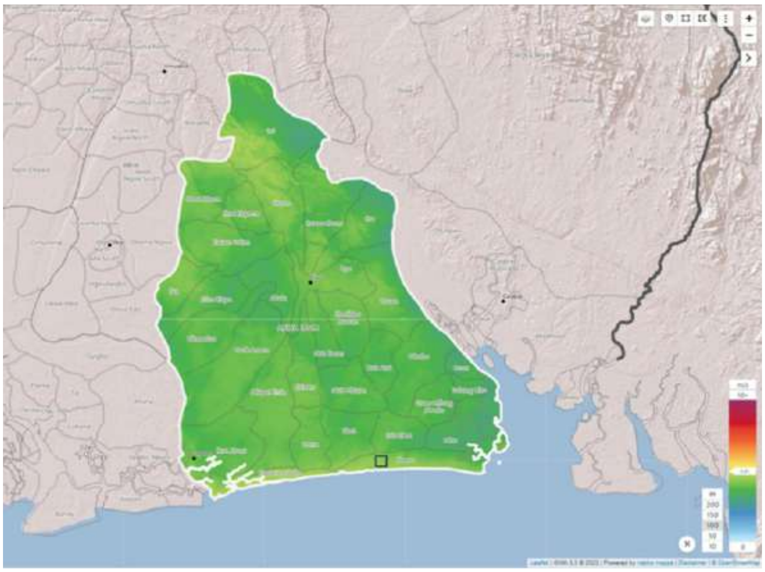


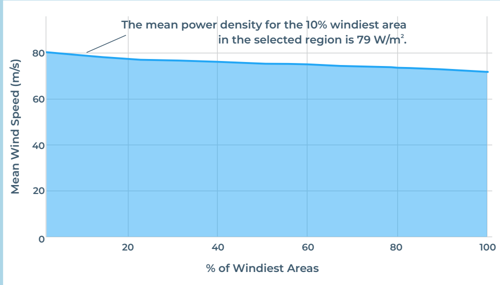
Wind Power Potential												
			50m		100m		150m		Worst Case Scenario			
State	Location	Coordinates	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Month
Akwa Ibom	Ibeno	4.562736°, 8.017273°	3.96	0.94	4.43	1.32	4.57	1.45	4.03	0.99	December
	Uyo	5.030755°, 7.925262°	3.22	0.51	4.01	0.98	4.65	1.52	3.57	0.69	December
Bayelsa	Yenegoa	4.945249°, 6.275042°	3.18	0.49	3.80	0.83	4.38	1.27	3.34	0.57	December
Cross River	Akamkpa	5.486134°, 8.633881°	7.14	5.52	7.24	5.75	7.09	5.40	5.79	2.94	December
	Yakurr	5.74171°, 8.1958°	4.55	1.43	5.37	2.35	6.21	3.63	4.56	1.44	December
	Calabar	5.0101°N, 8.3172°E	2.88	0.36	3.40	0,60	3.67	0.75	3.03	0.42	December
Delta	Warri North	5.915215°, 5.449219°	4.42	1.31	4.93	1.82	5.50	2.52	4.14	1.08	December
	Escravos Terminal	5.512297°, 4.961639°	4.74	1.61	5.17	2.09	5.24	2.18	4.50	1.38	May
Edo	Uromi, Esan North-East	6.725302°, 6.285553°	4.85	1.73	5.88	3.08	6.59	4.34	4.88	1.76	December
	Esan South-East	6.533039°, 6.300435°	4.95	1.184	5.85	3.03	6.53	4.22	4.80	1.67	December
	Uhunmwonde	6.663395°, 5.820849°	4.57	1.45	5.44	2.44	6.26	3.72	4.52	1.40	December
Rivers	Port Harcourt	4.767705°, 7.019234°	3.49	0.64	4.10	1.04	4.75	1.62	3.69	0.76	September
	Bonny	4.397075°, 7.179565°	4.20	1.12	4.65	1.52	4.79	1.67	4.23	1.15	May

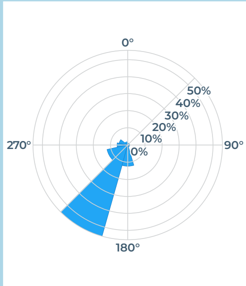


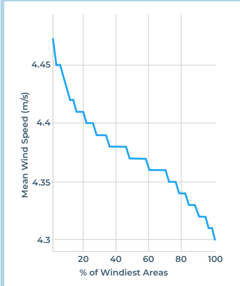
Akwa Ibom State – Ibeno Beach: This is one of the longest sandy beaches in West Africa, stretches approximately 30km along the Atlantic coast. Its low-lying, level coastal plain, formed by sedimentary deposits, ensures steady onshore and offshore winds due to its direct exposure to the Bight of Bonny. The adjacent Qua Iboe River estuary significantly impacts the hydrological system, while nearby mangrove ecosystems stabilize the shoreline and enhance biodiversity.

A popular tourist destination, Ibeno Beach has also been affected by oil exploration, influencing local land use and infrastructure —key factors for wind energy assessments.

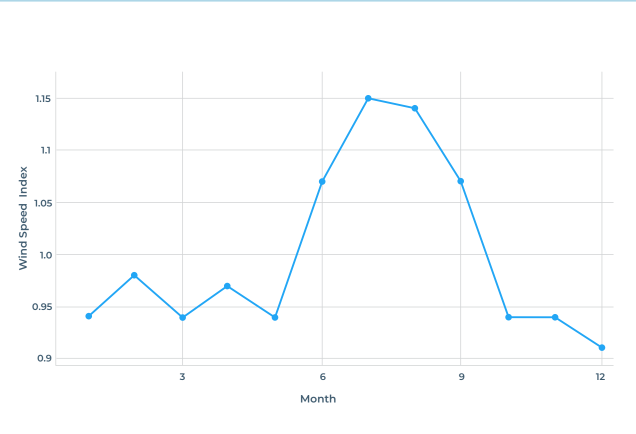


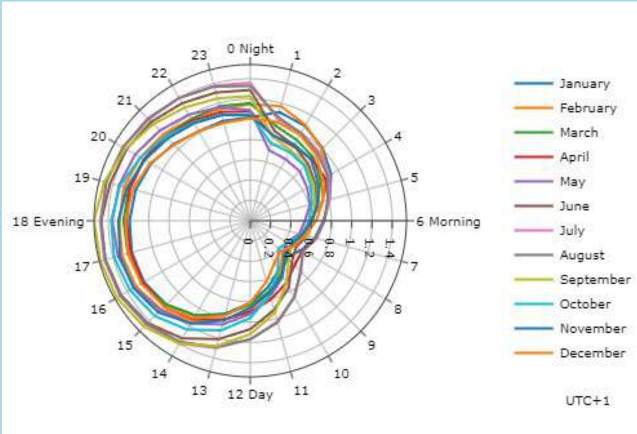






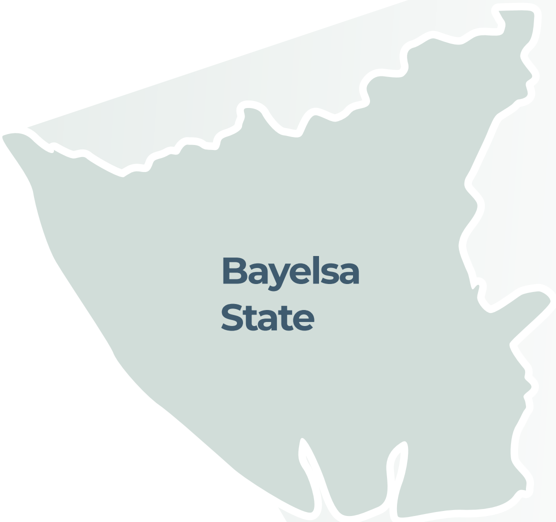
The wind rose diagram of Ibeno beach, suggests that the wind blows predominantly from the Southwest directions at a mean wind speed of 4.43 m/s and mean power density of 79 W/m² at 10% of the windiest area.





The wind speed in Ibeno beach peaks in August at 5.10 m/s and is lowest in December at 3.90 m/s. At peak period, we generate up to 1.29MW with the low case generation capacity at 0.64MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
4.562736°, 8.017273°	Akwa Ibom (South South)	Ibeno, Akwa Ibom State	50m	3.96m/s	61W/m²
			100m	4.43m/s	79W/m²
			150m	4.57m/s	87W/m²

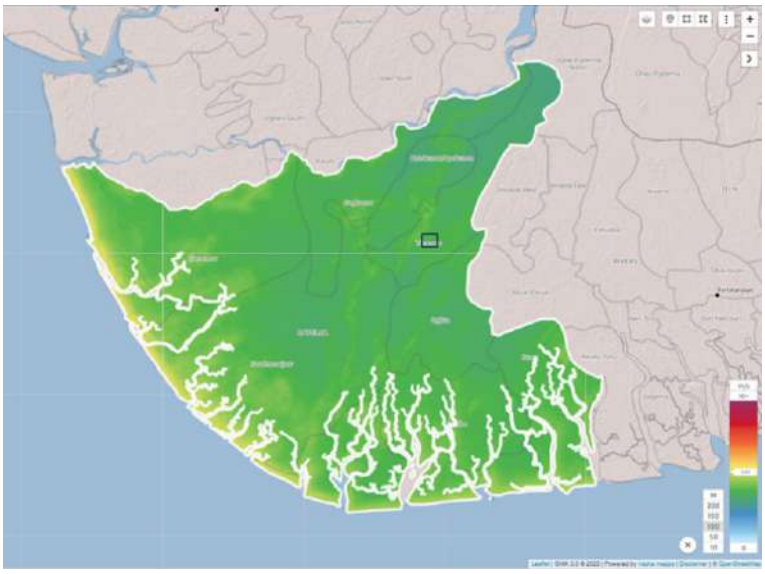


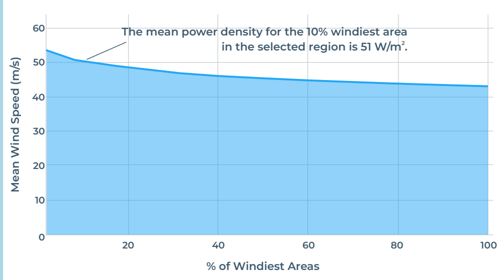
Bayelsa State - Yenagoa: The capital of Bayelsa State, is nestled in the Niger Delta in a low-lying swampy setting with tropical rainforests, mangroves, and water channels.

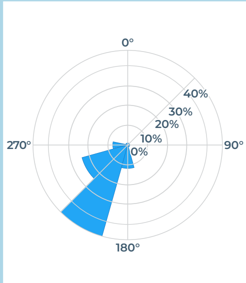
With a population of about 524,400 as of 2022, its terrain features gentle relief typical of deltaic landscapes, with elevations between -16m and 89m.

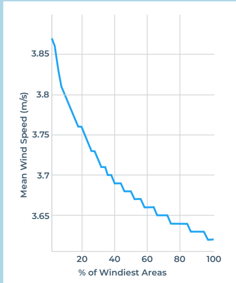
Traditional agriculture and fishing coexist with modern urban infrastructure, including government buildings and commercial hubs.

A complex hydrological network, comprising rivers, swamps, and seasonal channels, interacts with dense vegetation to create intricate wind patterns and microclimatic conditions, necessitating in-depth meteorological assessments to maximize wind energy potential.

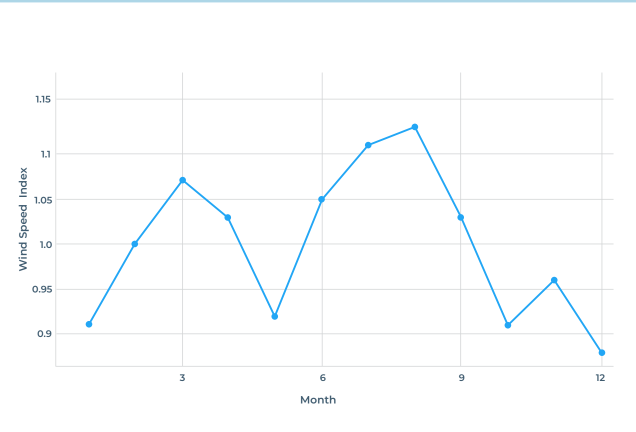


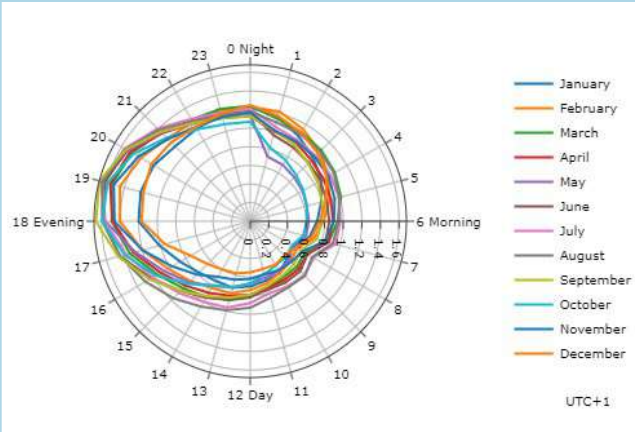






The wind rose diagram of Yenegoa, suggests that the wind blows predominantly from the Southwest direction at a mean wind speed of 3.80 m/s and mean power density of 51 W/m² at 10% of the windiest area. The wind in Yenegoa is not the best but still benefit from emerging technologies that utilize turbines that generate energy in low areas.



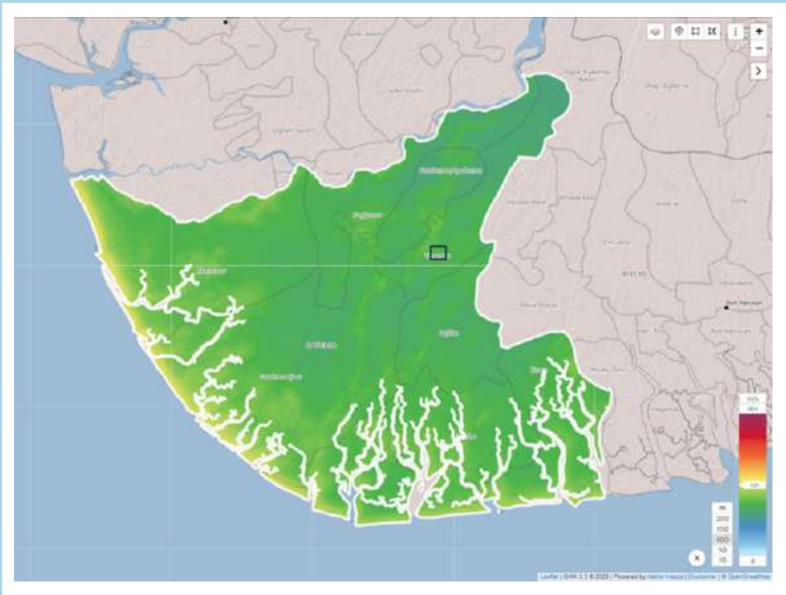


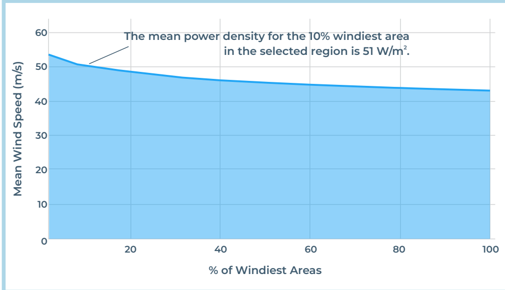
The wind speed in Yenegoa peaks in August at 4.43 m/s and is lowest in December at 3.34 m/s. At peak period, we generate up to 0.79MW with the low case generation capacity at 0.36MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

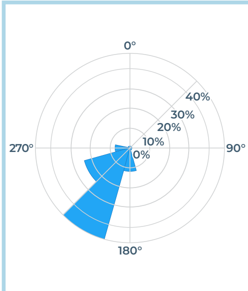
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
4.945249°, 6.275042°	Bayelsa (South South)	Yenegoa, Bayelsa State	50m	3.18m/s	34W/m²
			100m	3.80m/s	51W/m²
			150m	4.38m/s	71W/m²

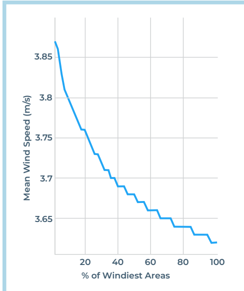
Bayelsa State - Brass: This is located on Brass Island and it covers a vast 90km coastal area along the Bight of Bonny. Home to traditional fishing and riverine trade communities, its coastal topography is shaped by estuarine dynamics between river and Atlantic influences, defined by a complex system of creeks, lagoons, and low-lying terrain.

The interaction of multiple water bodies and limited coastal vegetation produces various microclimates, modulating consistent wind behavior. Brass's potential for wind energy and regional growth is highlighted by its thriving traditional economy and new interests in sustainable development.

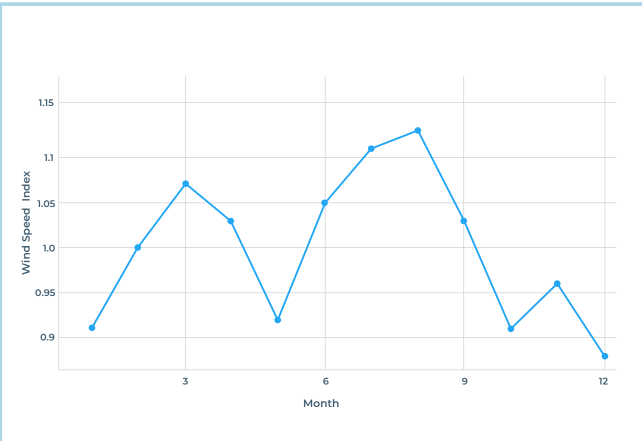


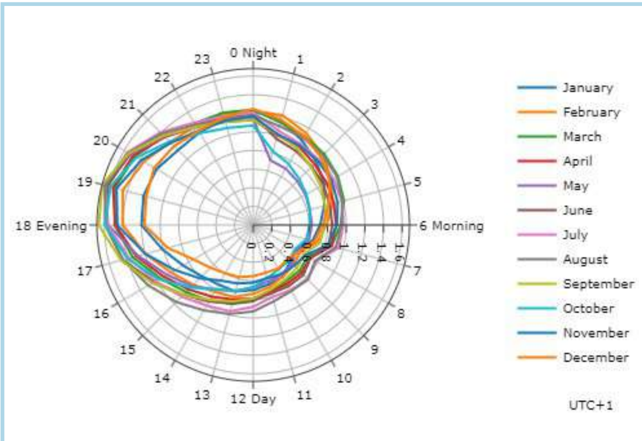






The wind rose diagram of Brass, suggests that the wind blows predominantly from the Southwest direction at a mean wind speed of 4.52 m/s and mean power density of 80 W/m² at 10% of the windiest area.





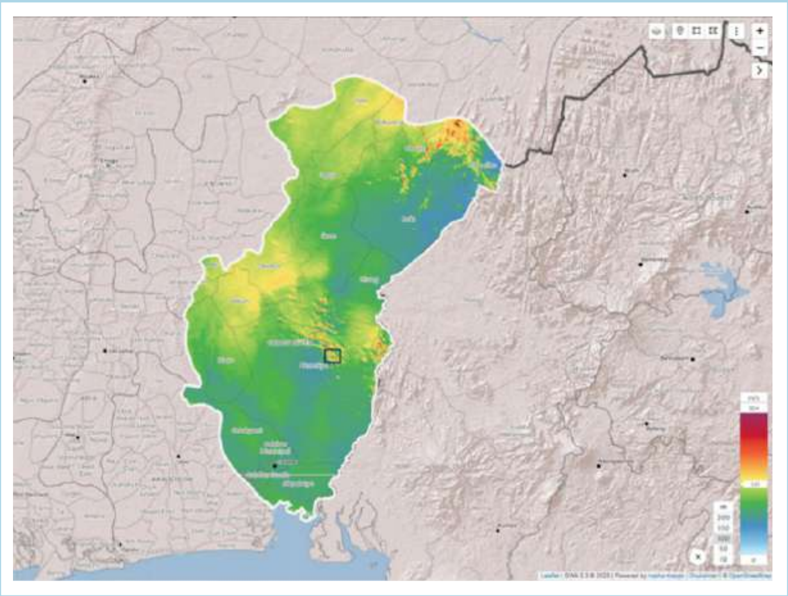
The wind speed in Brass peaks in August at 4.33 m/s and is lowest in December at 5.11 m/s. At peak period, we generate up to 1.29MW with the worst-case generation capacity at 0.65MW, assuming we have 120m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%. Average power generation capacity per turbine is 0.90MW.

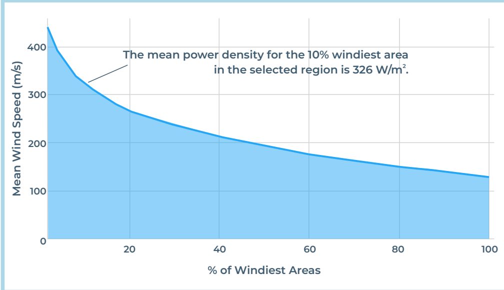
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
4.3078°, 6.2456°	Bayelsa (South South)	Brass, Bayelsa State	50m	4.12m/s	65W/m²
			100m	4.52m/s	80W/m²
			150m	4.76m/s	91W/m²

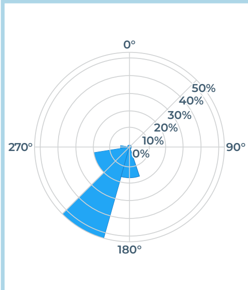
Cross River State - Akamkpa: This is the local government area in Cross River State, features diverse settlements and varied terrain ranging from sea level to about 1,100m. The region's topography, including hills, valleys, and coastal margins, supports a thriving rural community with pockets of emerging development.

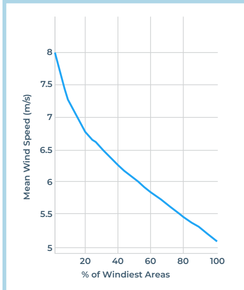
Hydrological features such as meandering streams, mangrove wetlands, and patches of virgin rainforest produce differential surface roughness and moisture gradients.

Rugged topography affects wind patterns and creates a variety of microclimates.

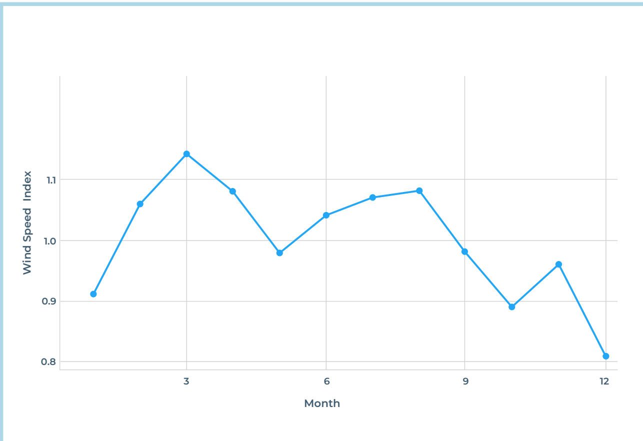


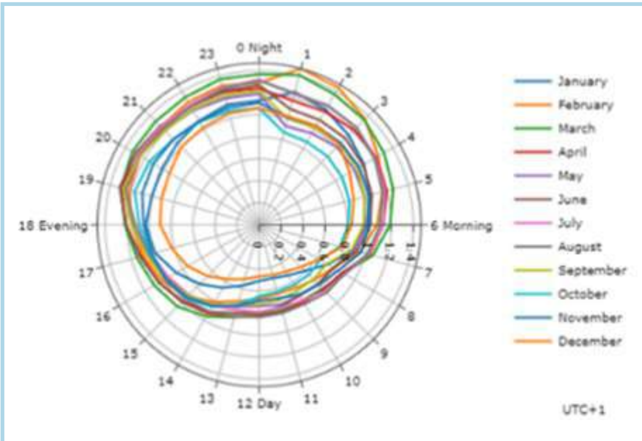






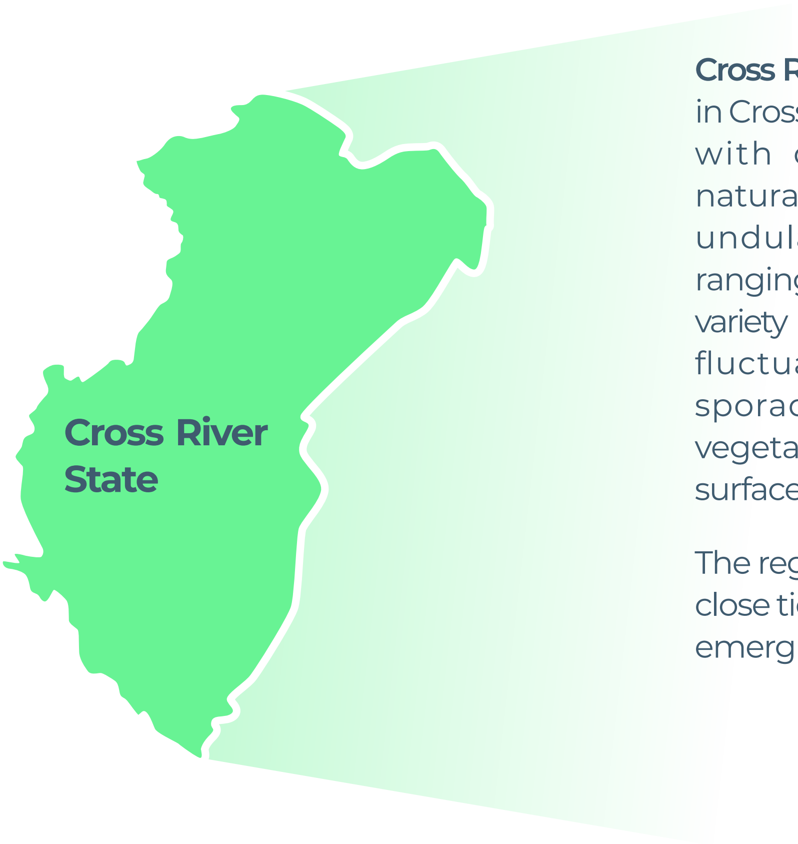
The wind rose diagram in the Akamkpa location indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 7.24 m/s and mean power density of 326 W/m² at 10% of the windiest area.





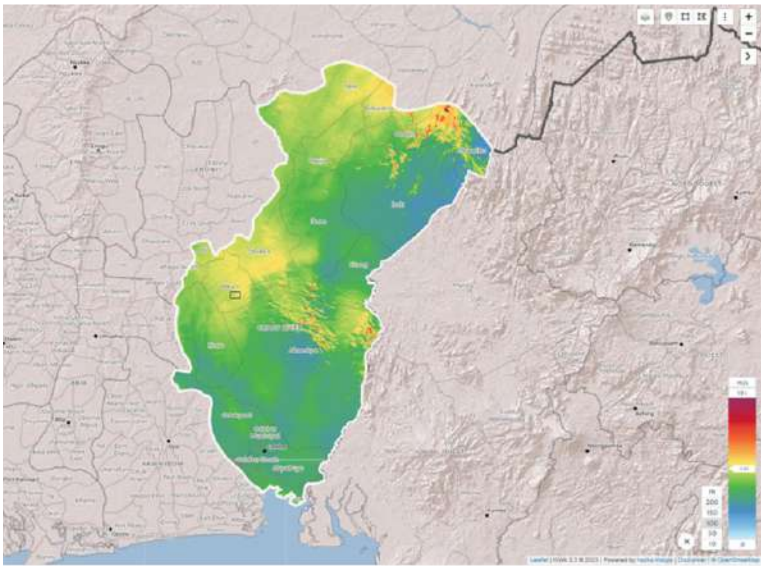
The wind speed peaks in February at 8.25 m/s and is lowest in December at 5.86 m/s. The low case power generation capacity in this location is 2.94MW assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

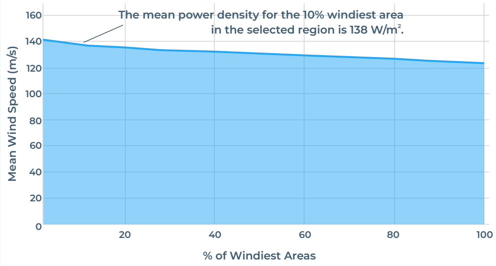
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
			50m	7.14m/s	347W/m²
5.486134°, 8.633881°	Cross River (South South)	Akamkpa, Cross River State	100m	7.24m/s	326W/m²
			150m	7.09m/s	307W/m²

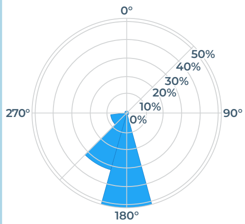


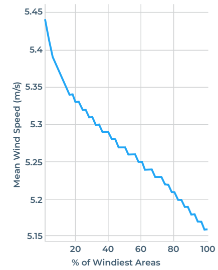
Cross River State - Yakurr: This is located in Cross River State, is primarily a rural area with communities dependent on natural resources and agriculture. Its undulating terrain, with elevations ranging from 11m to 273m, encourages a variety of wind patterns and microclimatic fluctuations. Seasonal streams and sporadic rainfall, along with tropical vegetation, help regulate airflow and surface roughness.

The region's changing infrastructure and close ties to traditional livelihoods indicate emerging socio-economic development.

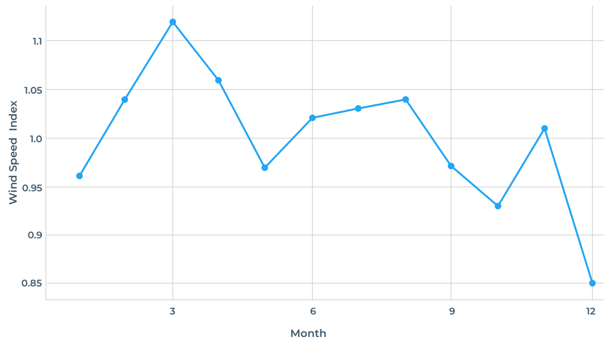


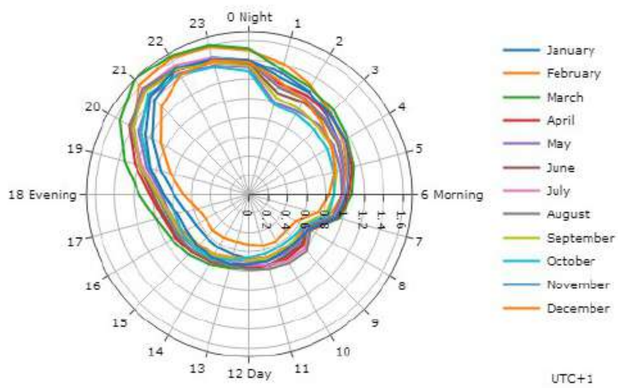






The wind rose diagram in Yakurr indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.37 m/s and mean power density of 138 W/m² at 10% of the windiest area.



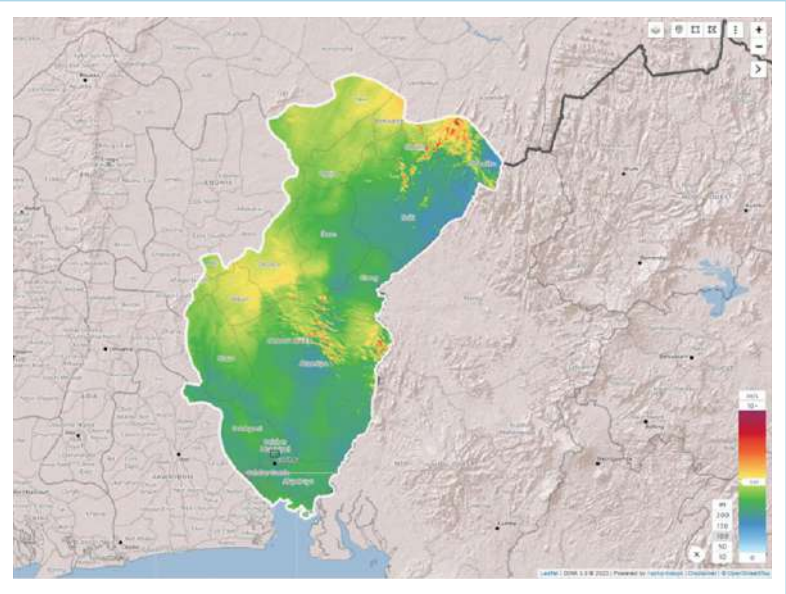


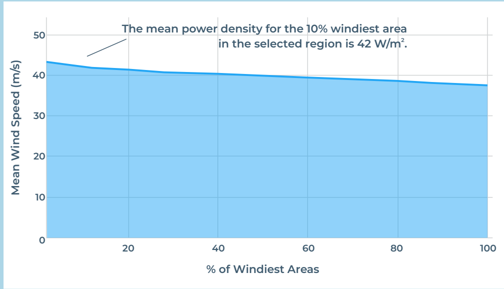
The wind speed peaks in February at 6.01 m/s and is lowest in December at 4.56 m/s. The low case power generation capacity in this location is 1.44MW assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

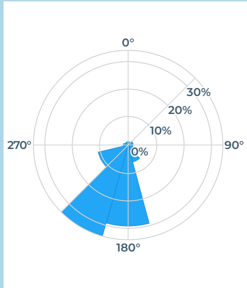
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
5.74171°, 8.1958°	Cross River (South South)	Yakurr, Cross River State	50m	4.55m/s	95W/m²
			100m	5.37m/s	138W/m²
			150m	6.21m/s	209W/m²

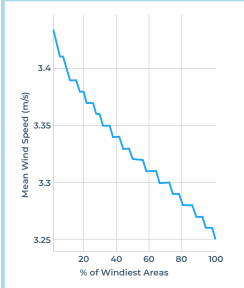
Cross River State - Calabar: A significant coastal city in Cross River State, is a center of commerce, government, and culture. Situated on low-lying terrain about 32m above sea level, it is dotted with coastal creeks near the confluence of the Calabar and Great Kwa Rivers. This gently sloping terrain, along with vast mangrove wetlands, creates unique microclimatic conditions with regular wind patterns.

Calabar's strategic significance in regional development is highlighted by its sophisticated urban infrastructure that blends with its natural coastal features.

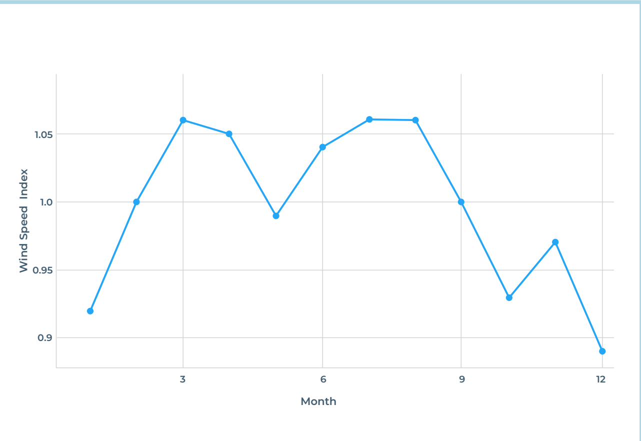


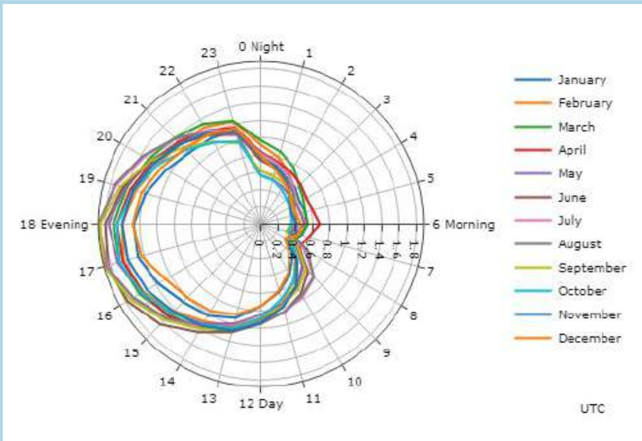






The wind rose diagram Calabar port area indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 3.40 m/s and mean power density of 42 W/m² at 10% of the windiest area.



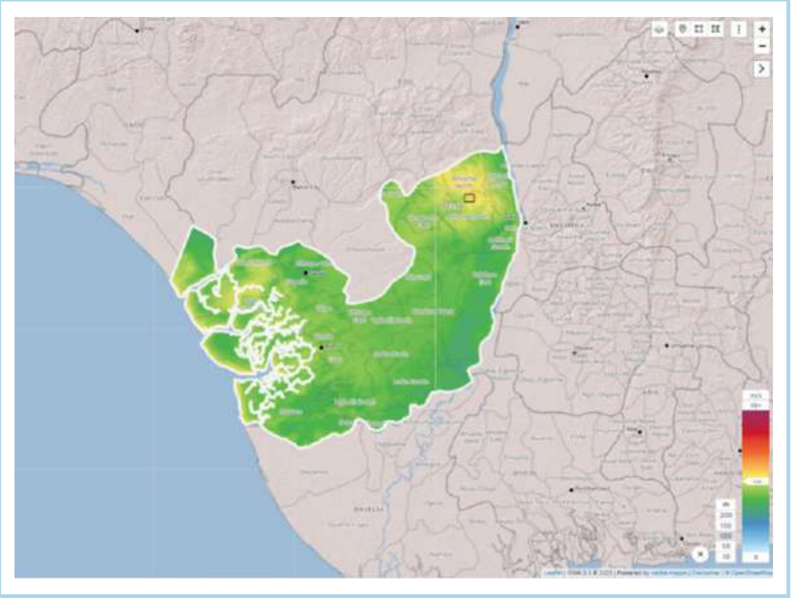


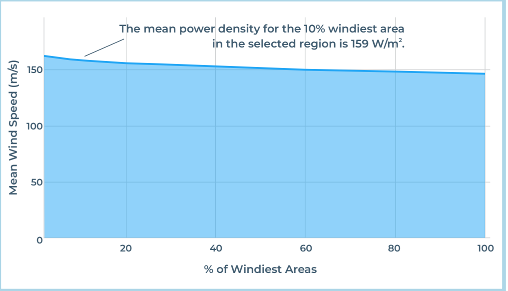
The wind speed peaks in February, July and August at 3.60 m/s and is lowest in December at 3.03 m/s. The low case power generation capacity in this location is 0.42MW assuming we have 120m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

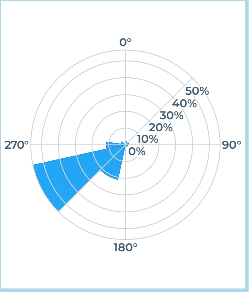
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
5.01011° N, 8.3172° E	Cross River (South South)	Calabar Port, Cross River State	50m	2.88m/s	30W/m²
			100m	3.4m/s	42W/m²
			150m	3.67m/s	54W/m²

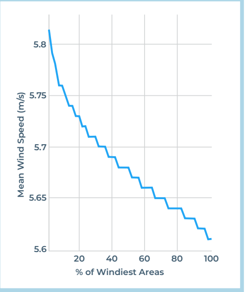
Delta State - Aniocha South: This area covers 868km² and is home to approximately 194,700 people. This region, a vital component of the Niger Delta ecosystem, includes both inland tropical rainforests and coastal mangrove swamps. The dynamic environment, with terrain varying from near sea level (about 10m) along the coast to inland elevations of up to 280m, shapes local wind flow.

Dense vegetation, tidal channels, and seasonal streams produce variable surface roughness and microclimatic variations.

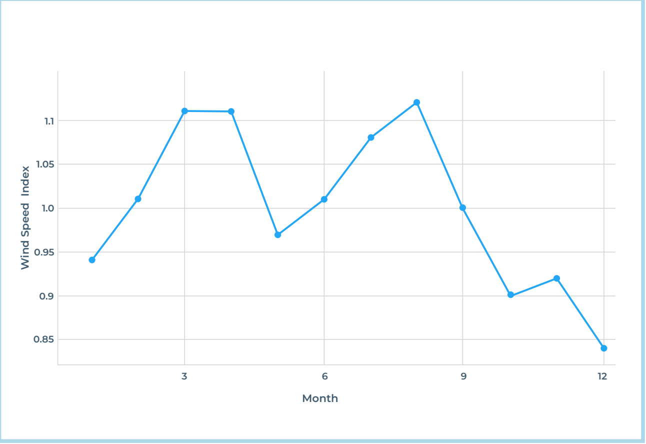


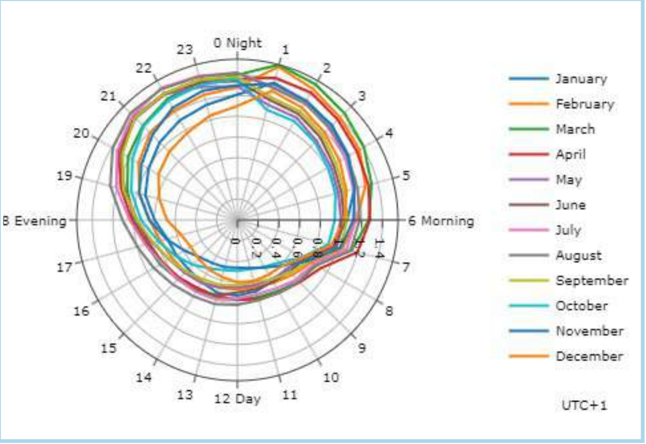






The wind rose diagram of Aniocha South indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.76 m/s and mean power density of 159 W/m² at 10% of the windiest area.



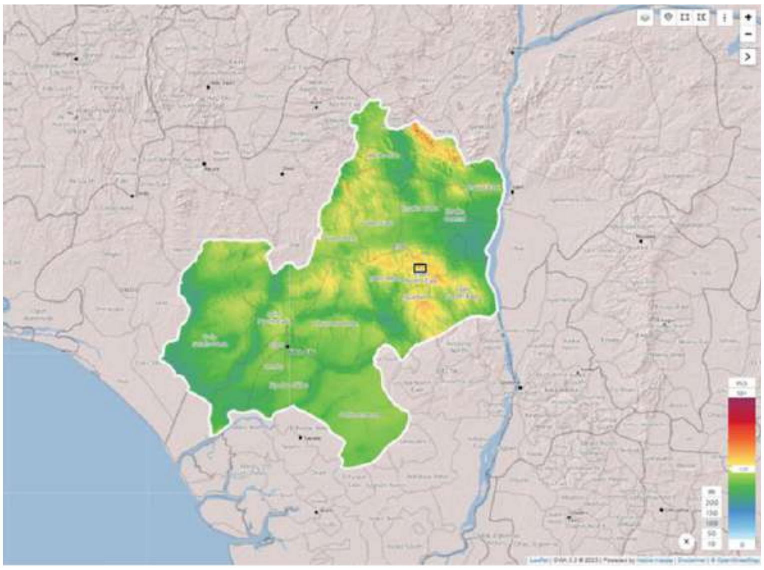


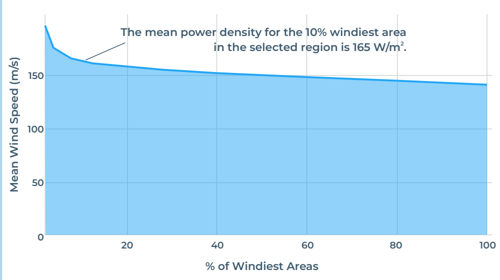
The wind speed in Aniocha South peaks in August at 6.45 m/s and is lowest in December at 4.84 m/s. At peak period, we can generate up to 2.60MW with the low case generation capacity at 1.10MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

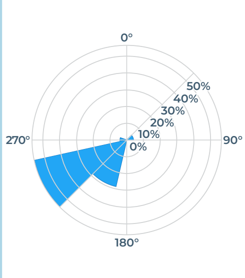
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.285269°, 6.520386°	Delta (South South)	Aniocha South, Delta State	50m	4.89m/s	109W/m²
			100m	5.76m/s	159W/m²
			150m	6.37m/s	221W/m²

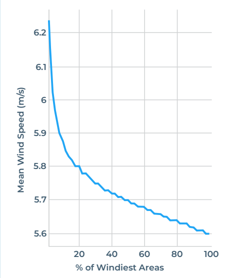
Edo State - Uromi, Esan Northeast: It is renowned for blending traditional ways of life with contemporary advancement. Although precise statistics on population and land area are limited, Uromi is surrounded by diverse landforms and undulating hills. The town's varied terrain greatly affects local wind dynamics, with elevations reaching up to 415m.

A network of rivers and streams traverses the region, resulting in varying surface roughness that influences microclimate and airflow. Uromi's dynamic environment fosters both economic development and cultural heritage.

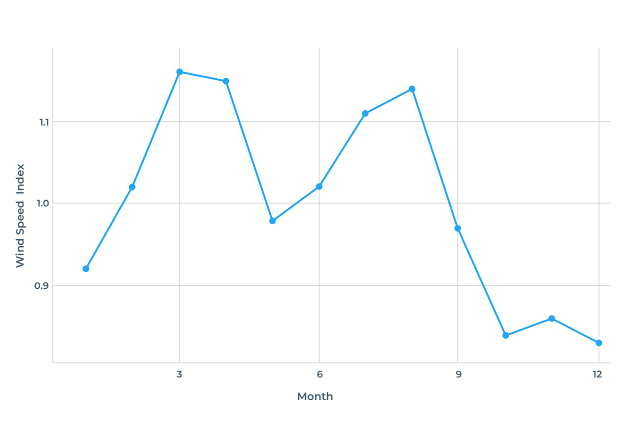


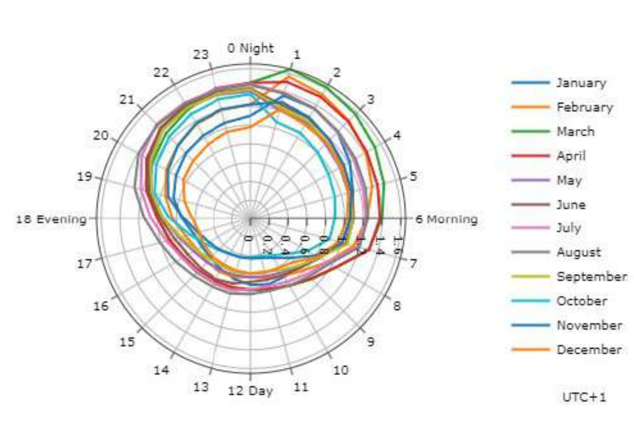






The wind rose diagram of Uromi, Esan Northeast indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.88 m/s and mean power density of 165 W/m² at 10% of the windiest area.



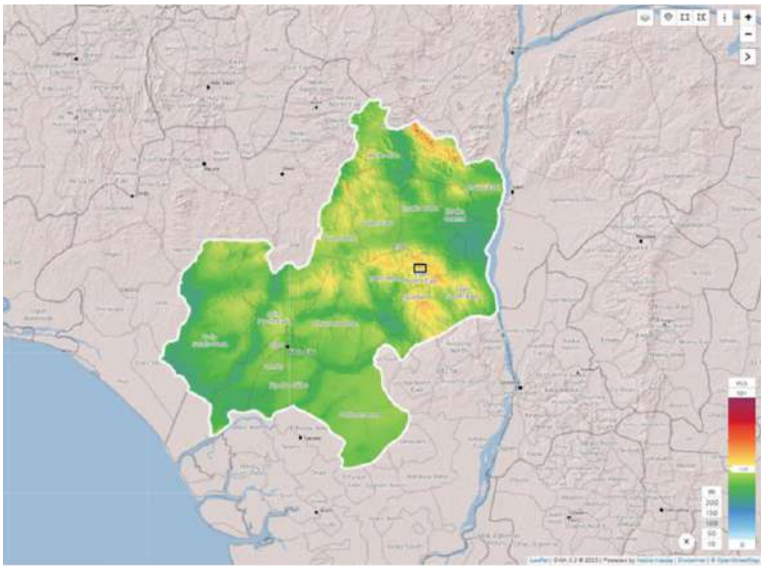


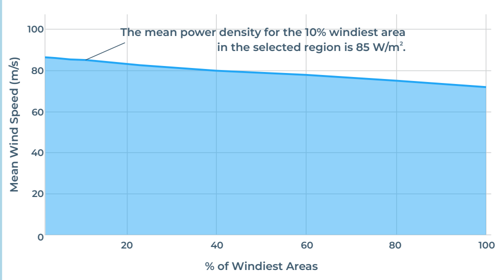
The wind speed in Uromi peaks in March at 6.94 m/s and is lowest in December at 4.88 m/s. At peak period, we can generate up to 3.24MW with the low case generation capacity at 1.13MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

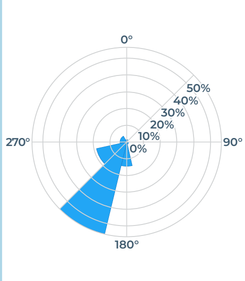
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.725302°, 6.285553°	Edo (South South)	Uromi, Esan North-East, Edo State	50m	4.85m/s	103W/m²
			100m	5.88m/s	165W/m²
			150m	6.59m/s	238W/m²

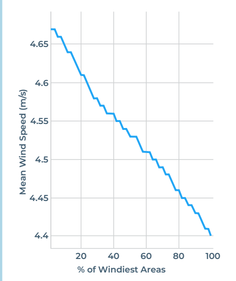
Rivers State - Bonny: It is located along the southern coast of Rivers State, covering about 645km² with a population of around 309,200. It borders Okrika and Khana LGAs to the north, Andoni LGA to the east, and Degema LGA to the west. The region features low-lying terrain, averaging 2m above sea level, with tropical rainforests and extensive mangrove swamps typical of the Niger Delta.

Bonny's climate includes a lengthy wet season from March to November, with substantial annual rainfall of about 4,698 mm. Temperatures range from 21°C to 31°C, rarely dropping below 18°C or rising above 32°C.

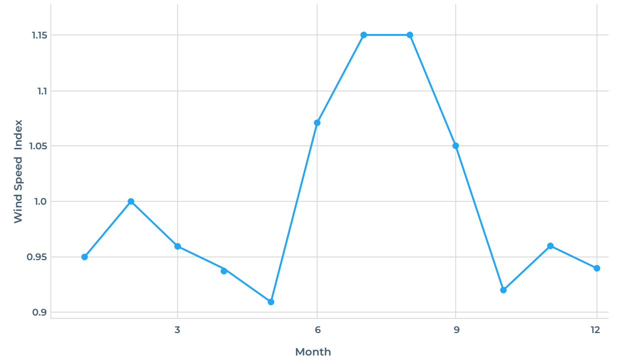


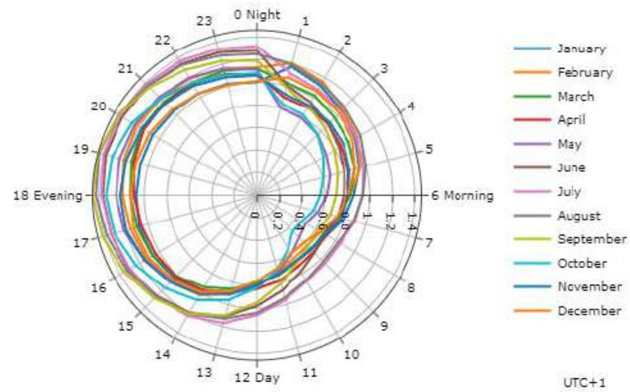






The wind rose diagram of Bonny Island indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 4.65 m/s and mean power density of 85 W/m² at 10% of the windiest area.

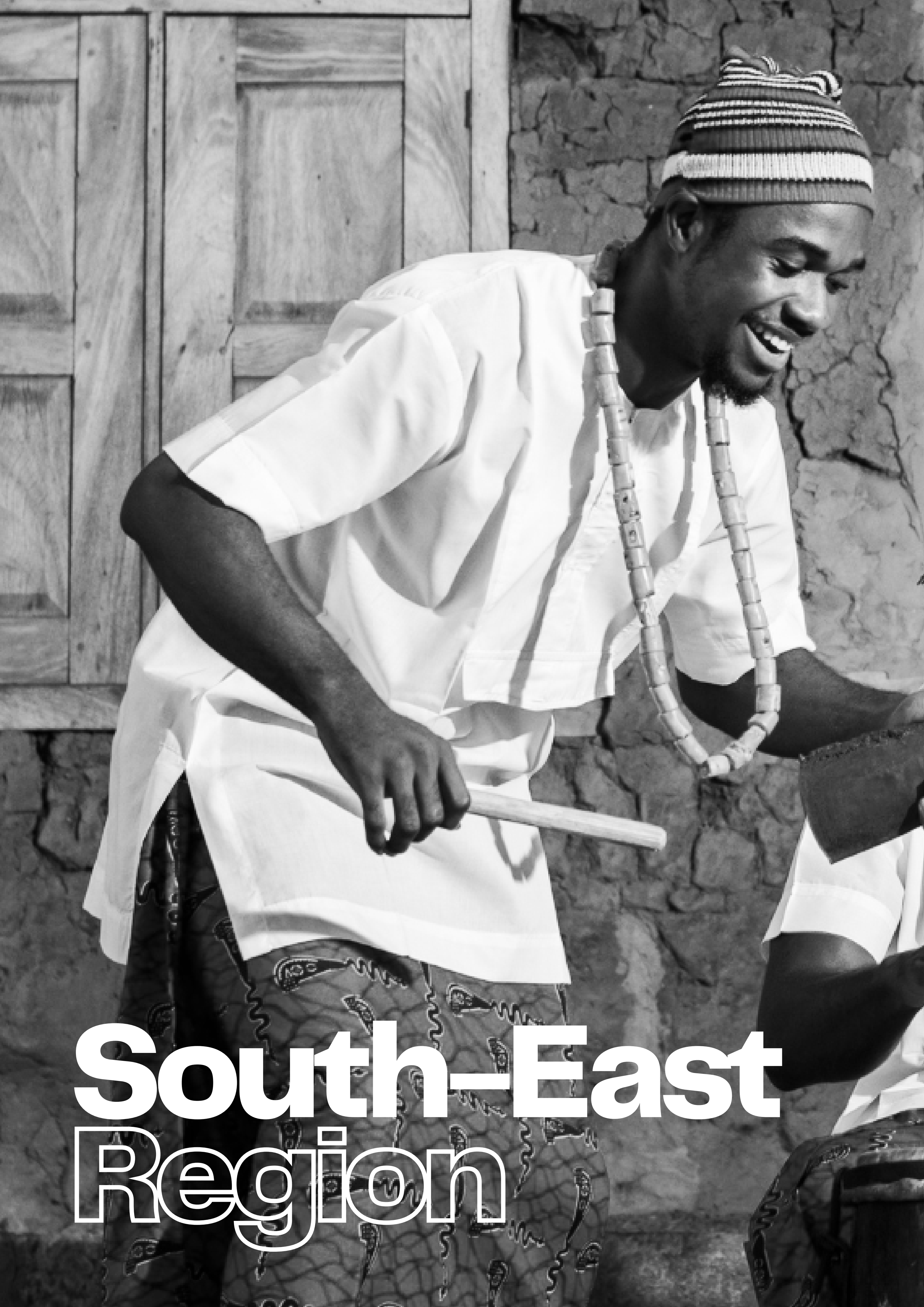




The wind speed in Bonny peaks in July and Augusth at 5.35 m/s and is lowest in May at 4.23 m/s. At peak period, we can generate up to 1.48MW with the low case generation capacity at 0.73MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
4.397075°, 7.179565°	Rivers (South South)	Bonny, Rivers State	50m	4.20m/s	69W/m²
			100m	4.65m/s	86W/m²
			150m	4.79m/s	94W/m²

Epie Community, Bayelsa State



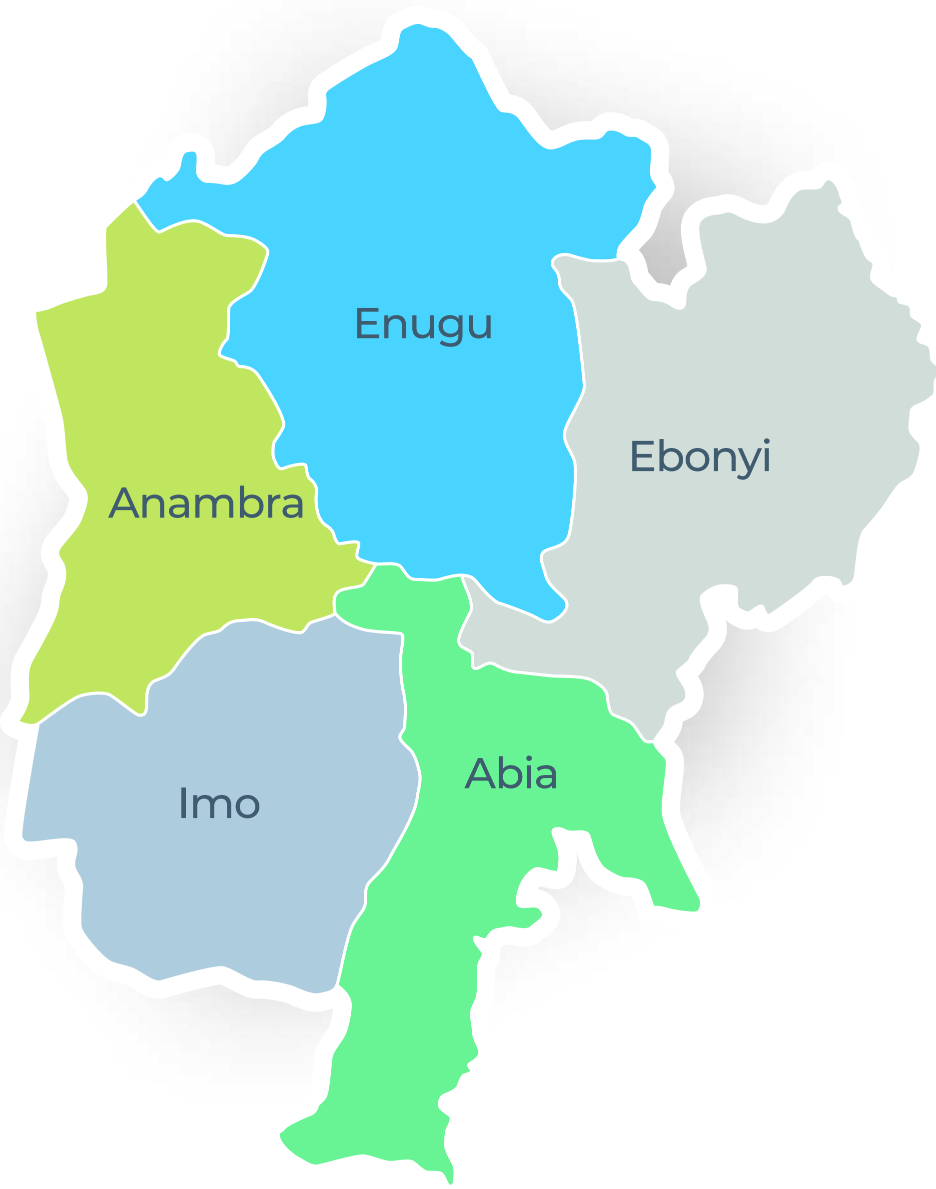
South-East Region

South-East Region

States: Abia, Anambra, Ebonyi, Enugu, and Imo.

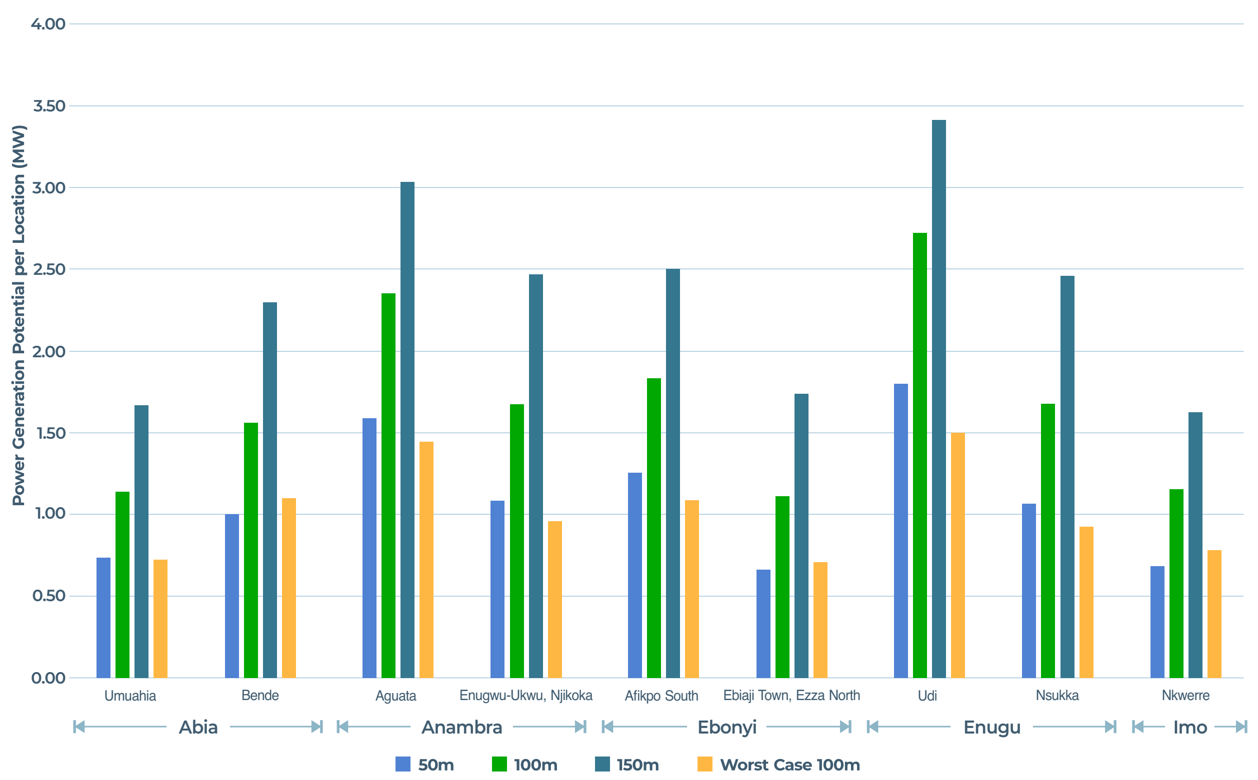
Summary: There are 5 states in the Southeastern geopolitical zone of Nigeria, and the region has a population of about 36 million people. It is popular for its business activities and local manufacturing industries. Aba and Enugu remain its most populous cities. 28.6% of the populace here has no access to electricity.

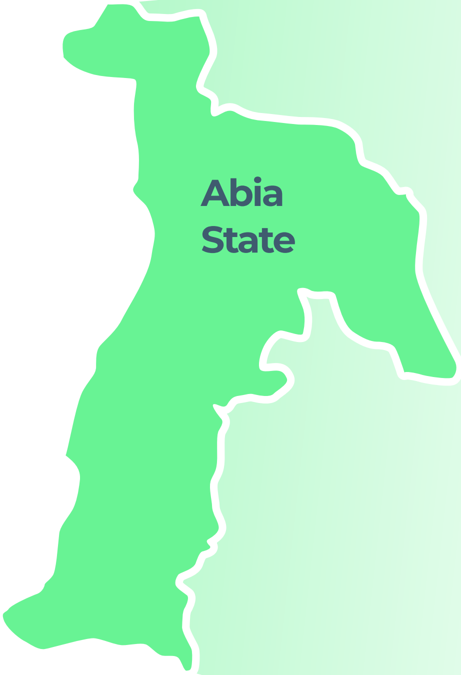
We have evaluated 9 locations across the region with Udi (Enugu) ranking highest in wind speed capacity.



Wind Power Potential												
			50m		100m		150m		Worst Case Scenario			
State	Location	Coordinates	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Month
Abia	Umuahia	5.518942°, 7.534561°	4.24	0.74	4.9	1.14	5.56	1.67	4.21	0.73	December
	Bende	5.728386°, 7.9600479°	4.7	1.01	5.44	1.56	6.19	2.30	4.84	1.10	December
Anambra	Aguata	6.048837°, 7.072636°	5.47	1.59	6.24	2.36	6.79	3.04	5.30	1.45	December
	Enugwu-Ukwu, Njikoka	6.193121°, 6.980817°	4.82	1.09	5.57	1.68	6.34	2.47	4.62	0.96	December
Ebonyi	Afikpo South	5.776019°, 7.833936°	5.06	1.26	5.74	1.83	6.37	2.51	4.82	1.09	December
	Ebiaji Town, Ezza North	6.216709°, 8.011881°	4.09	0.66	4.86	1.11	5.64	1.74	4.18	0.71	December
Enugu	Udi	6.500899°, 7.414033°	5.70	1.80	6.55	2.73	7.06	3.41	5.37	1.50	October
	Nsukka	6.873862°, 7.340672°	4.79	1.07	5.57	1.68	6.33	2.46	4.57	0.92	October
Imo	Nkwerre, Imo State	5.762204°, 7.083958°	4.13	0.68	4.92	1.16	5.51	1.62	4.33	0.79	October

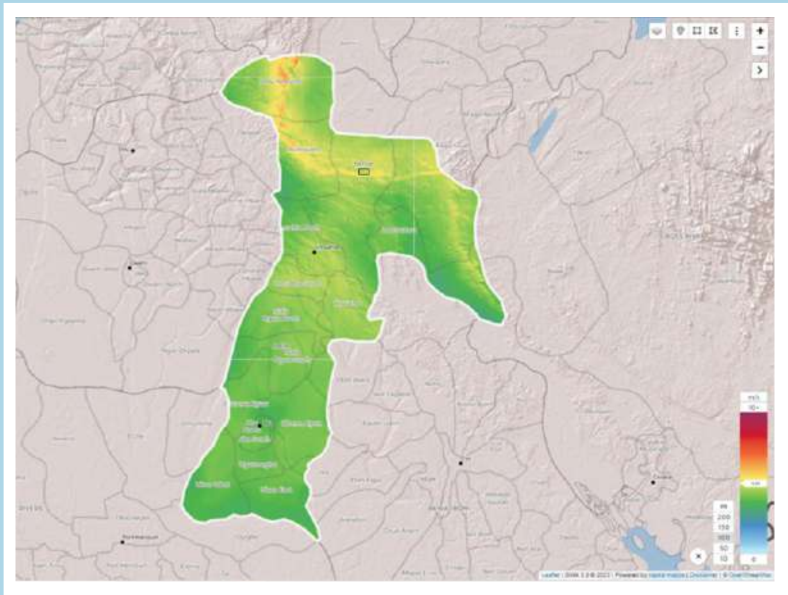
Power Generation Potential @ 50m, 100m and 150m Heights for South-East Nigeria

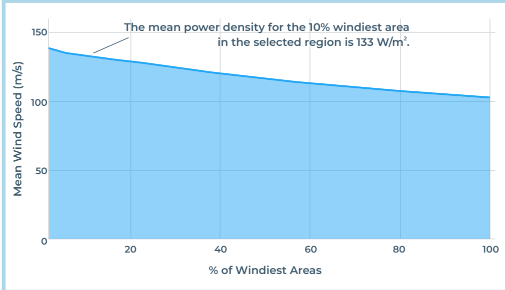


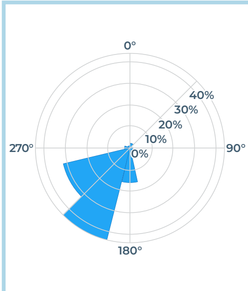


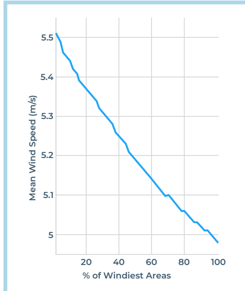
Abia State – Bende: This location covers approximately 590.8km², with a population of 192,621 in 2006, projected to grow to 280,500 by 2022. The region features undulating terrain with elevations ranging from 50m to 141m, characterized by high sandstone highlands and shale lowlands. Its hydrology and wind dynamics are influenced by several rivers, including the Imo, Esu, Akpoha, Igu, and Aba.

While the outskirts are predominantly rural, Bende's urban core, bustling with modern commercial centers, showcases a blend of traditional and emerging development.

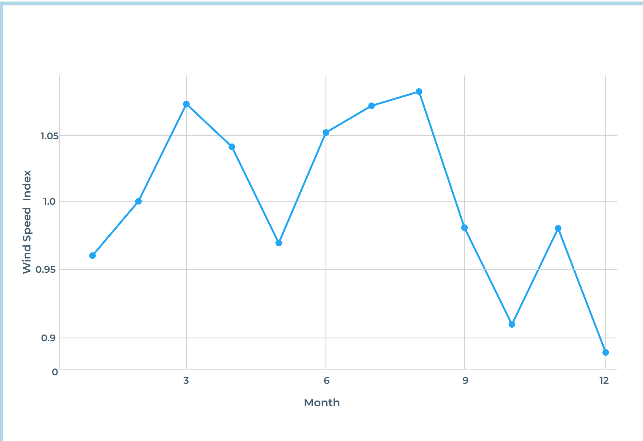


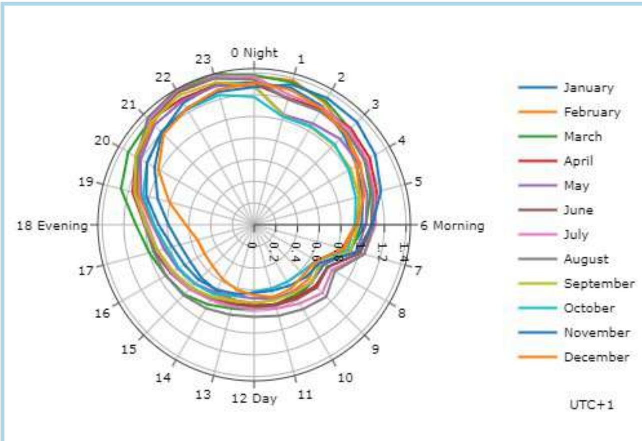






The wind rose diagram of Bende indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.44 m/s and mean power density of 133 W/m² at 10% of the windiest area.





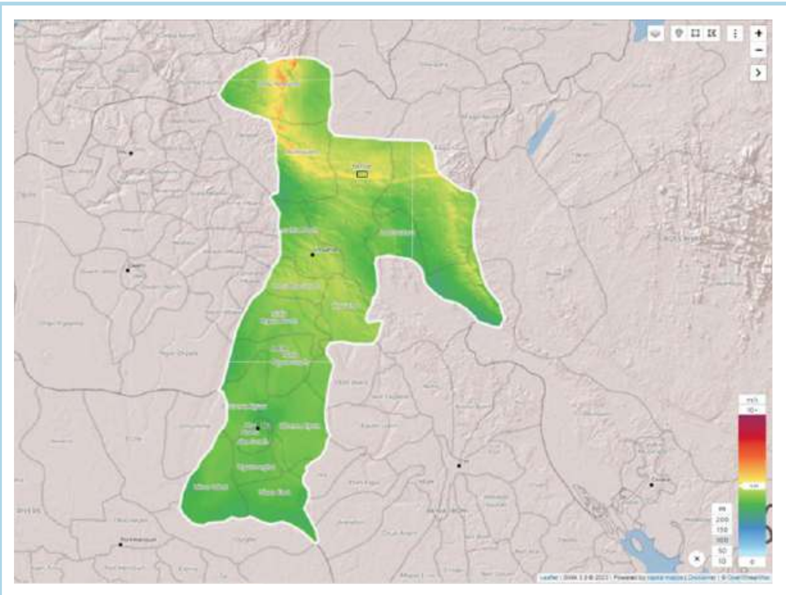
The wind speed in Bende peaks in August at 5.88 m/s and is lowest in December at 4.84 m/s. At peak period, we generate up to 1.97MW with the low case generation capacity at 1.10MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

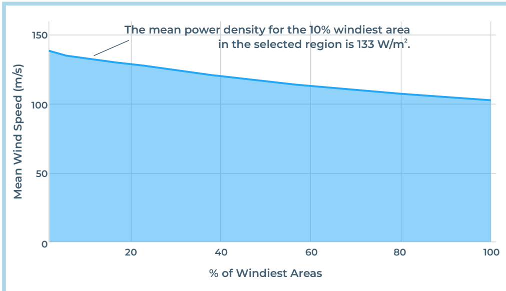
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
5.728386°, 7.600479°	Abia (South East)	Bende, Abia State	50m	6.43m/s	97W/m²
			100m	5.44m/s	133W/m²
			150m	6.19m/s	191W/m²

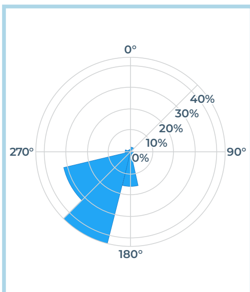
Anambra – Aguata, Orumba North: This location is at an elevation of about 307m, features gently sloping terrain that forms natural channels affecting local airflow.

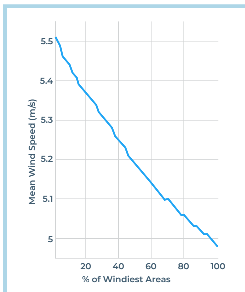
The region, along with nearby Orumba North, exhibits a mix of established rural communities and new urban settlements.

The interaction of elevation, hydrological forces, and changing demographic trends influences local land use and infrastructure development.





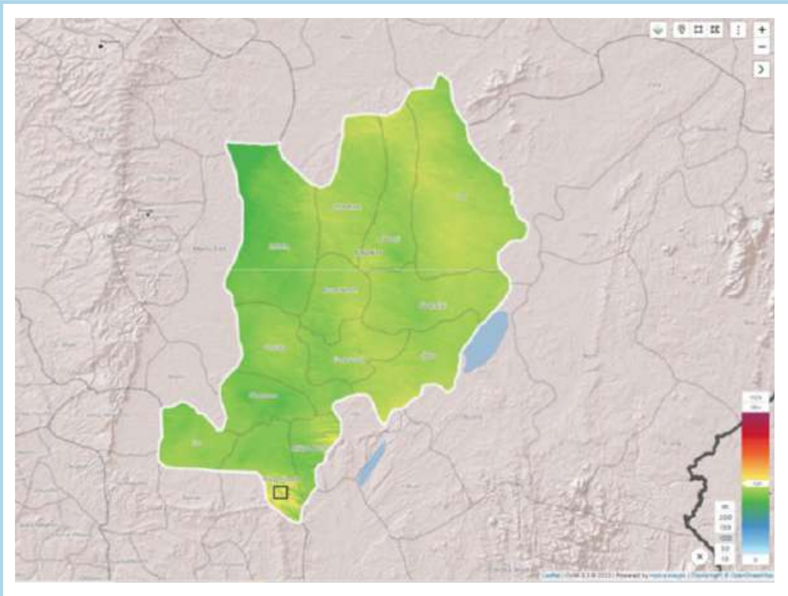


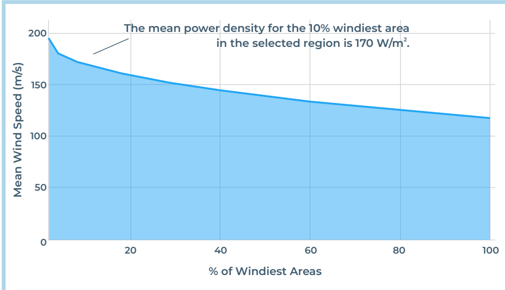


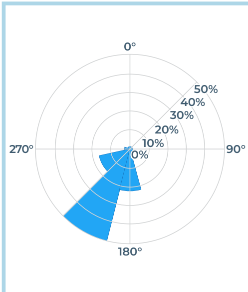
The wind rose diagram of Aguata indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 6.24 m/s and mean power density of 244 W/m² at 10% of the windiest area.

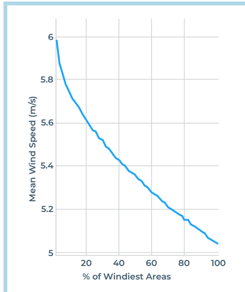
Ebonyi State – Afikpo South: It is a transitional area where open grasslands give way to tropical forests, covering approximately 378.1km². Elevations range from roughly 12m to 271m, affecting local wind dynamics. Infrastructure advancements indicating sustainable growth coexist with traditional agricultural methods.

Contrasting landscapes produce variable surface roughness, and hydrological dynamics further alter wind direction and speed to create complex microclimates.

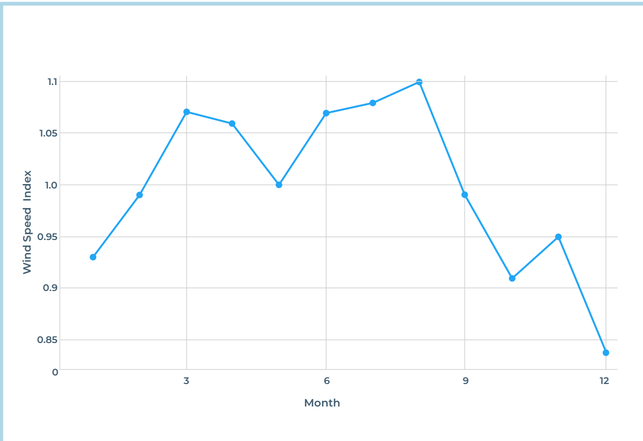


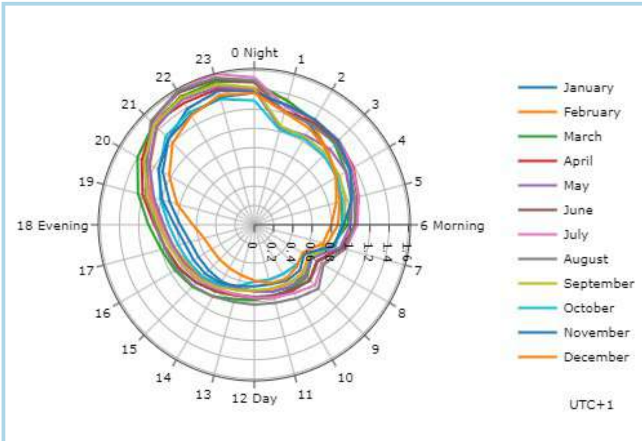






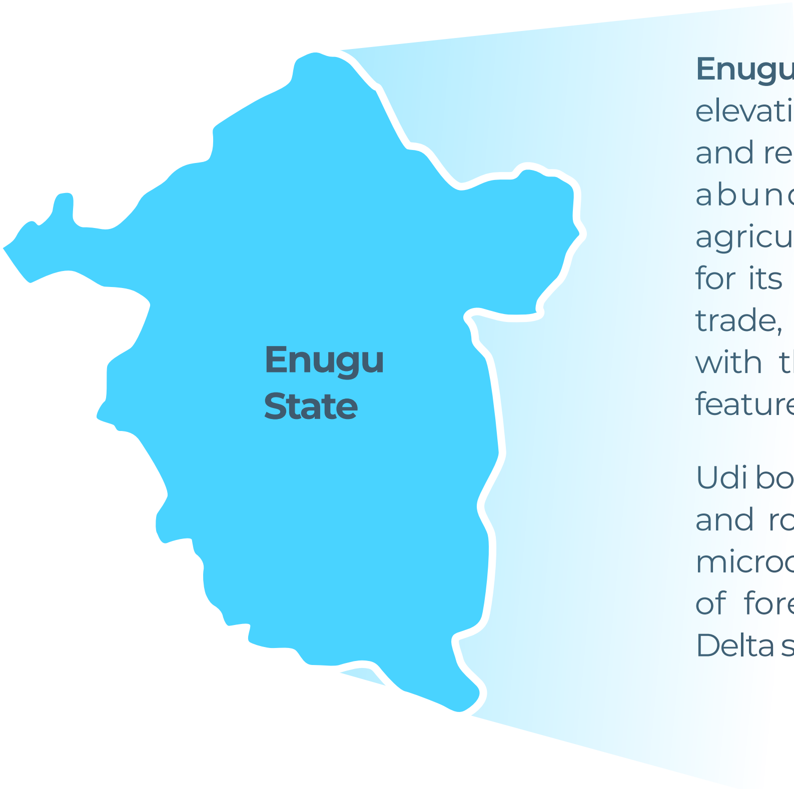
The wind rose diagram of Afikpo indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.74 m/s and mean power density of 140 W/m² at 10% of the windiest area.





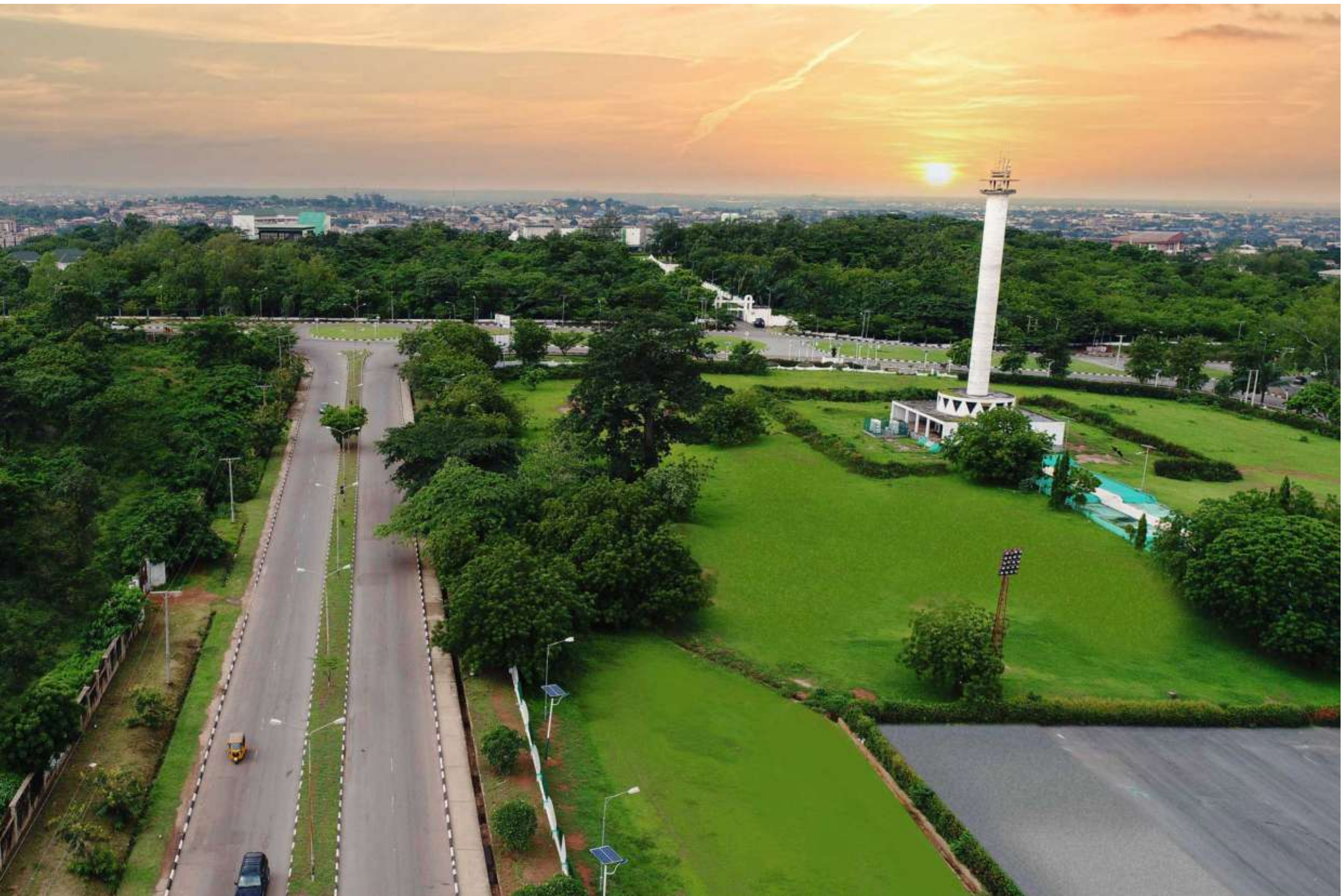
Afikpo South's wind peaks in August at 6.31 m/s and is lowest in December at 4.82 m/s. At peak period, we generate up to 2.44MW with the low case generation capacity at 1.09MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

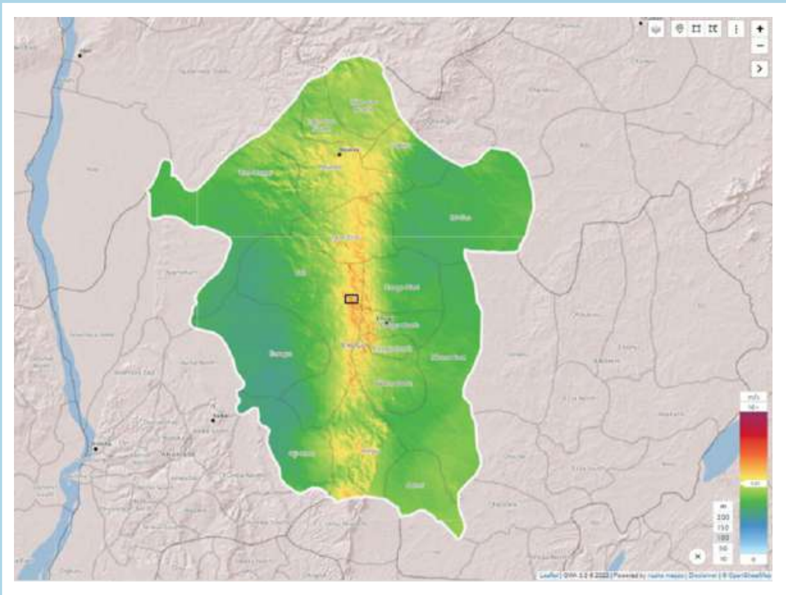
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
5.776019°, 7.833936°	Ebonyi (South East)	Nguzu Edda, Ebonyi State	50m	5.08m/s	134W/m²
			100m	5.75m/s	170W/m²
			150m	6.38m/s	232W/m²

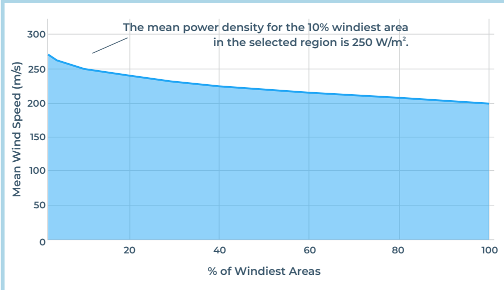


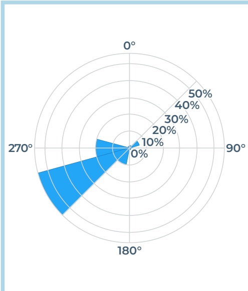
Enugu State - Udi: This location is at an elevation of over 200m above sea level, and renowned for its rich cultural legacy, abundant vegetation, and strong agricultural output. The region, known for its limestone deposits that fuel local trade, is home to various ethnic groups, with the Udi people predominating. It features rolling hills, streams, and caves.

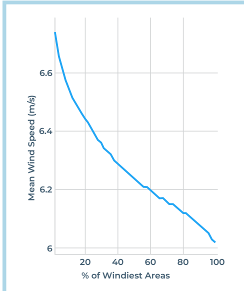
Udi boasts excellent educational facilities and road connections, and its dynamic microclimate, shaped by the interaction of forest-savanna mosaics and Niger Delta swamps.



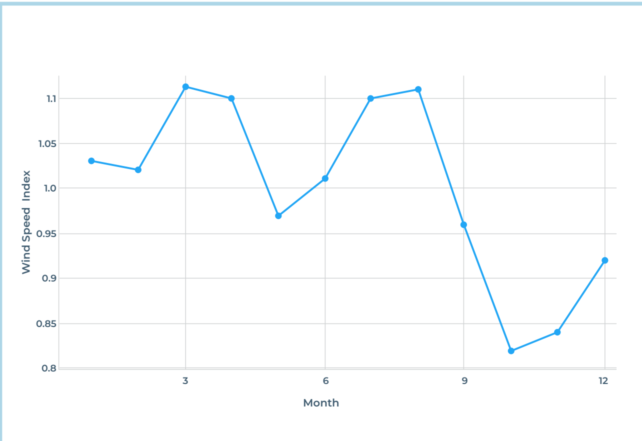


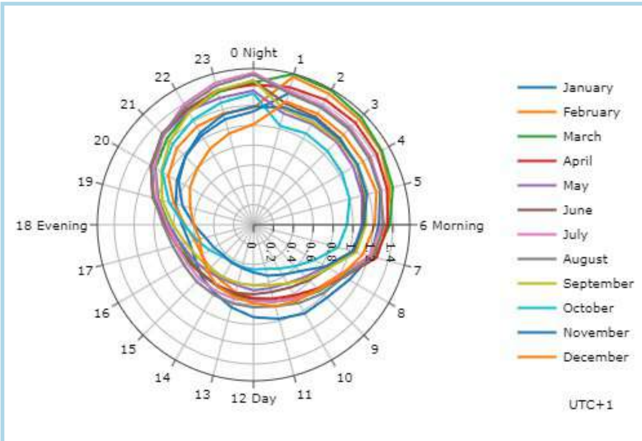






The wind rose diagram for Udi indicates the wind blowing predominantly from the Southwest and West directions at a mean wind speed of 6.55 m/s and mean power density of 250 W/m² at 10% of the windiest area.



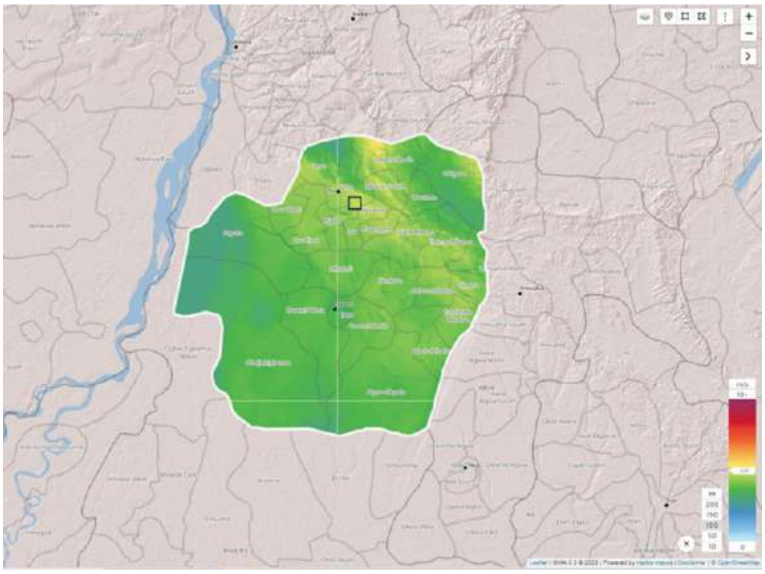


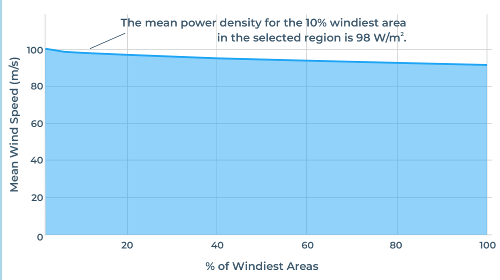
Udi's wind peaks in August at 7.27 m/s and is lowest in December at 5.37 m/s. At peak period, we generate up to 3.73MW with the low case generation capacity at 1.50MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

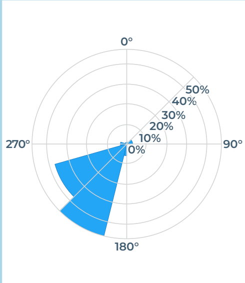
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
6.500899°, 7.414033°	Enugu (South East)	Udi, Enugu State	50m	5.7m/s	189W/m²
			100m	6.55m/s	250W/m²
			150m	7.06m/s	318W/m²

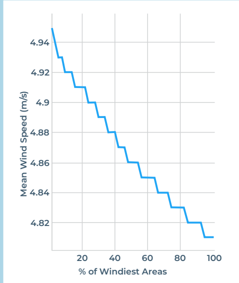
Imo State – Nkwerre: This location spanning 38.447km² in southeast Nigeria, features diverse land cover, including forests, grasslands, croplands, and shrubs. The town's elevation fluctuates locally by up to 159m due to differential heating and cooling, resulting in localized wind circulations.

Nkwerre's hydrology and geography, influenced by the Iyibeke stream and the Orashi River's tributaries, produce localized thermal and humidity gradients.

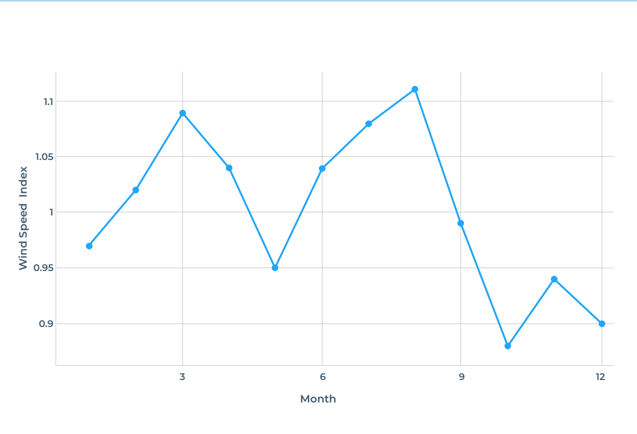


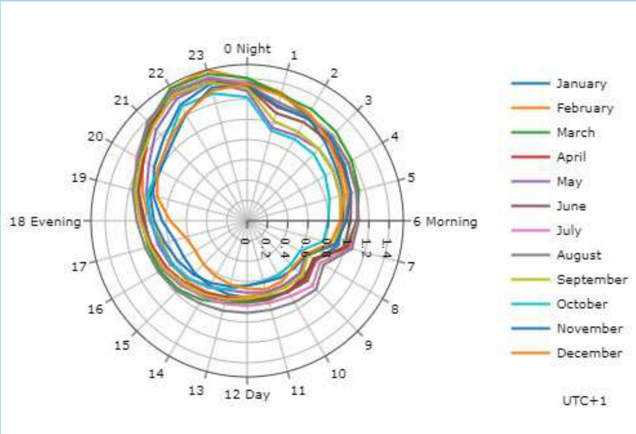






The wind rose diagram for Nkwerre indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 4.92 m/s and mean power density of 98 W/m² at 10% of the windiest area.

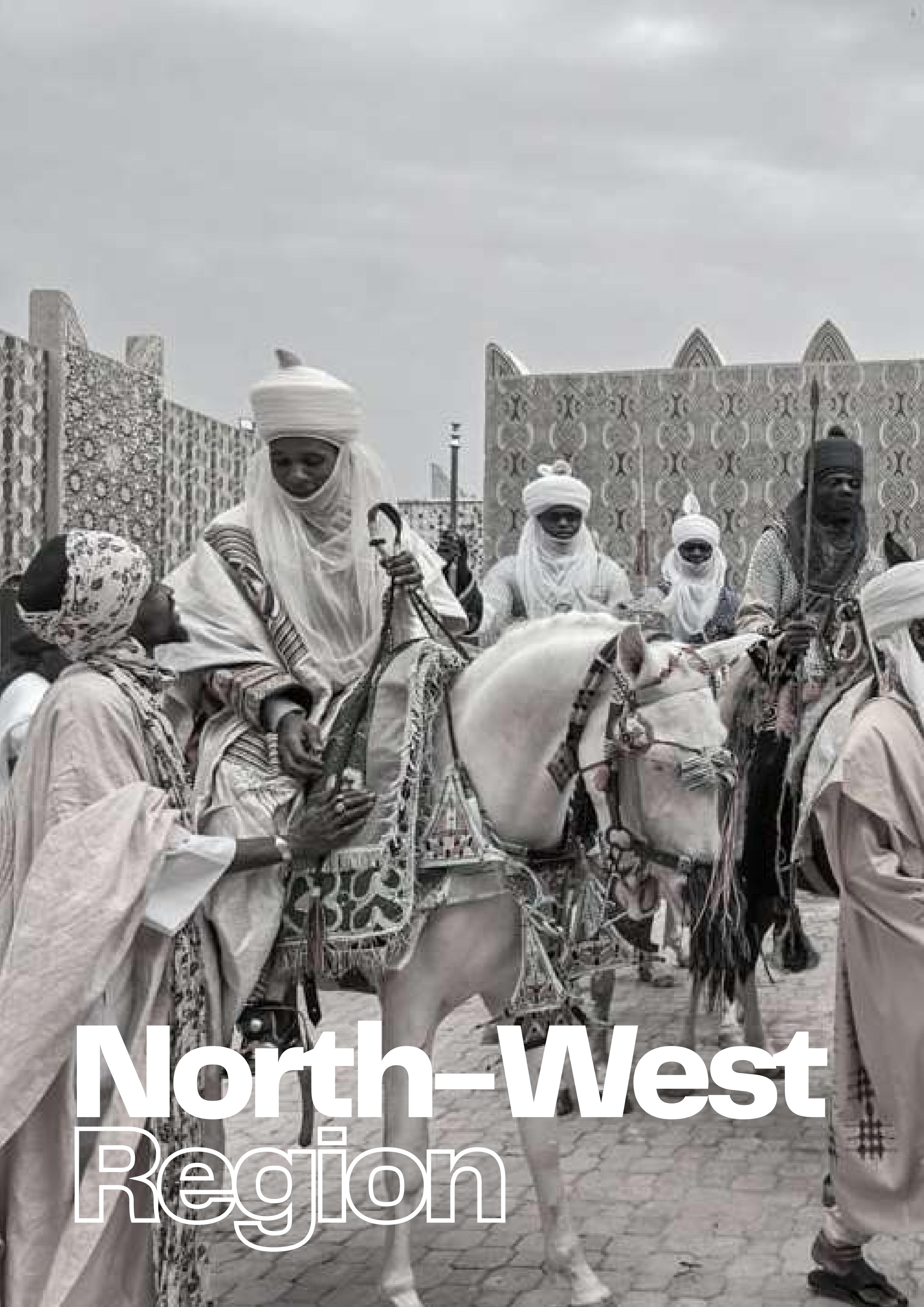




Nkwerre's wind peaks in August at 5.46 m/s and is lowest in October at 4.33 m/s. At peak period, we generate up to 1.58MW with the low case generation capacity at 0.79MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
5.762204°, 7.083958°	Imo (South East)	Nkwerre, Imo State	50m	4.13m/s	66W/m²
			100m	4.92m/s	98W/m²
			150m	5.51m/s	142W/m²

Ada Palm Plantation, Imo State



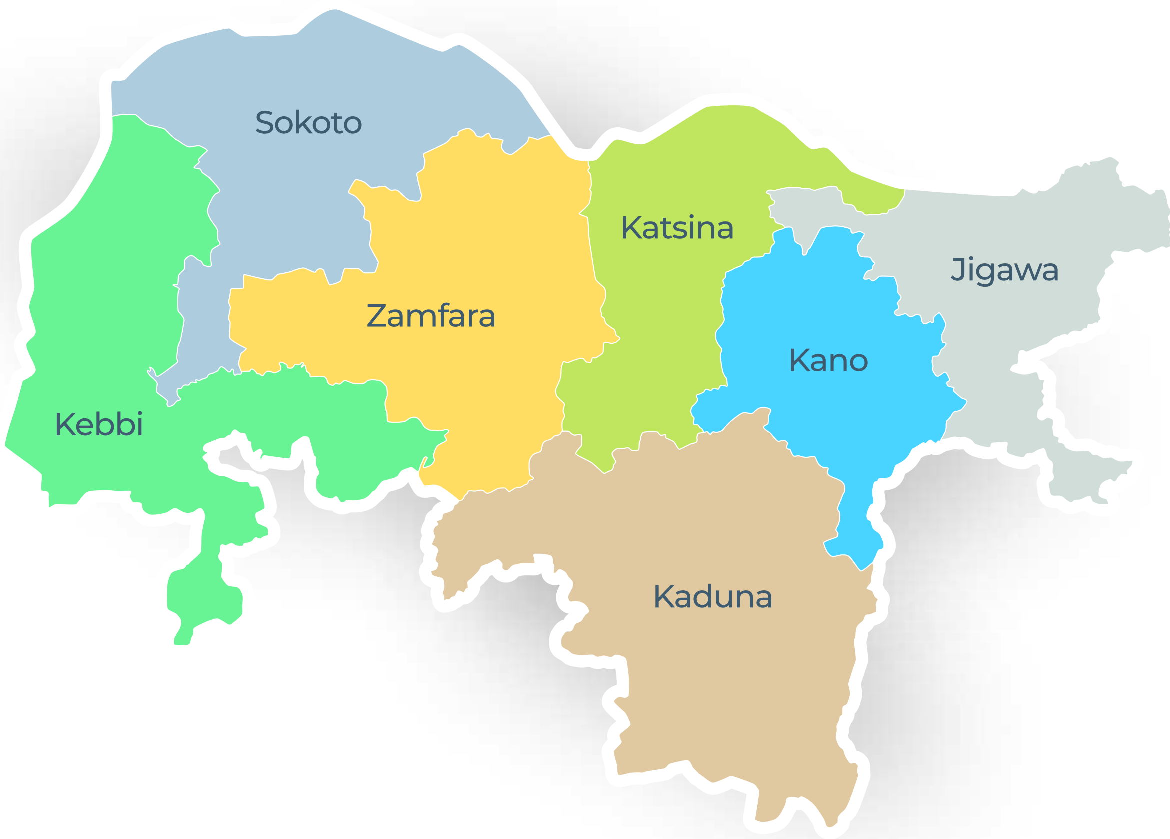
North–West Region

North-West Region

States: Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara.

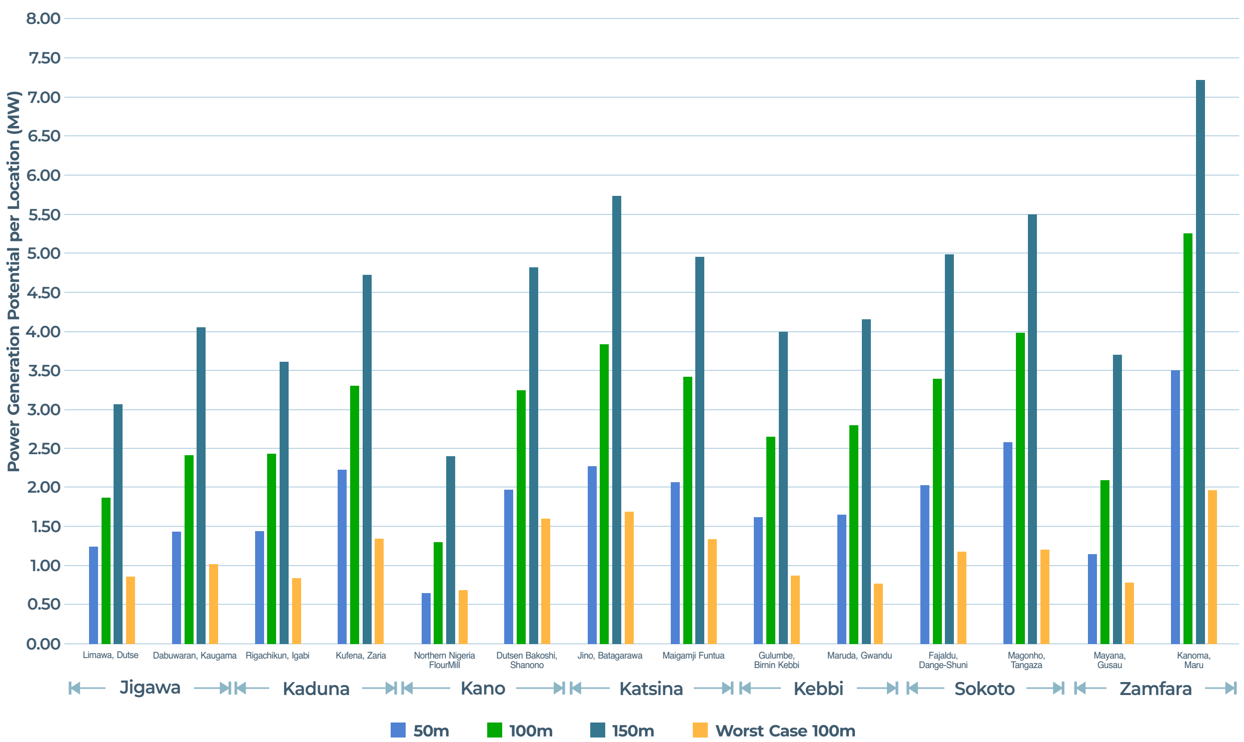
Summary: The Northwest of Nigeria is the most populous geopolitical zone in the country with a population of 49 million people, representing almost 35% of the country's population. According to the UN, 70% of the populace live below the poverty line. 59.7% of the region has no access to electricity with majority of the supply in the area (97.3%) gotten from the national grid. Kano, the commercial nerve center of Northern Nigeria is the most populated city in the region and a renewable energy solution in the ancient city could help boost economic activities and lift the citizenry out of poverty. The land mass in the Northwest, arguably the largest in the country allows it to be an agricultural haven and improved power from the abundant wind resources could help improve mechanized farming.

The wind resource in the Northwest is fantastic with wind speeds up to 8.1 m/s in Zamfara and the lowest in our study area being at the Northern Nigeria Flour Mill facility in Kano, 5.1 m/s. These speeds are at 100m heights.



Wind Power Potential											
			50m		100m		150m		Worst Case Scenario		
State	Location	Coordinates	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Month
Jigawa	Limawa, Dutse	11.76086°, 9.346482°	5.04	1.24	5.78	1.87	6.81	3.06	4.45	0.86	November
	Dabuwaran, Kaugama	12.396379°, 9.762689°	5.29	1.44	6.29	2.41	7.48	4.06	4.72	1.02	October
Kaduna	Rigachikun, Igabi	10.662632°, 7.453537°	5.29	1.44	6.31	2.44	7.19	3.61	4.42	0.684	October
	Kufena, Zaria	11.089808°, 7.657127°	6.12	2.22	6.99	3.31	7.87	4.73	5.17	1.34	October
Kano	Northern Nigeria Flour Mill	12.023119°, 8.563478°	4.03	0.63	5.1	1.29	6.28	2.40	4.13	0.68	October
	Dutsen Bakoshi, Shanono	12.03059°, 7.939164°	5.88	1.97	6.94	3.24	7.92	4.82	5.48	1.60	September, October
Katsina	Jino, Batagarawa	12.914891°, 7.559888°	6.16	2.27	7.34	3.84	8.39	5.73	5.58	1.68	October
	Maigamji, Funtua	11.492287°, 7.325058°	5.96	2.05	7.06	3.41	7.99	4.95	5.15	1.33	October
Kebbi	Gulumbe, Birnin Kebbi	12.348647°, 4.381014°	5.50	1.61	6.49	2.65	7.44	3.99	4.48	0.87	October
	Maruda, Gwandu	12.582265°, 4.749374°	5.54	1.65	6.6	2.79	7.54	4.16	4.29	0.77	October
Sokoto	Fajaldu, Dange-Shuni	12.843938°, 5.39978°	5.93	2.02	7.04	3.38	8.01	4.98	4.93	1.16	October
	Magonho, Tangaza	13.53386°, 5.018005°	6.43	2.58	7.43	3.98	8.27	5.49	4.8	1.20	October
Zamfara	Mayana, Gusau	12.165541°, 6.660805°	4.90	1.14	6	2.10	7.25	3.70	4.32	0.78	October
	Kanoma, Maru	12.235339°, 6.297913°	7.12	3.50	8.15	5.25	9.06	7.21	5.87	1.96	October

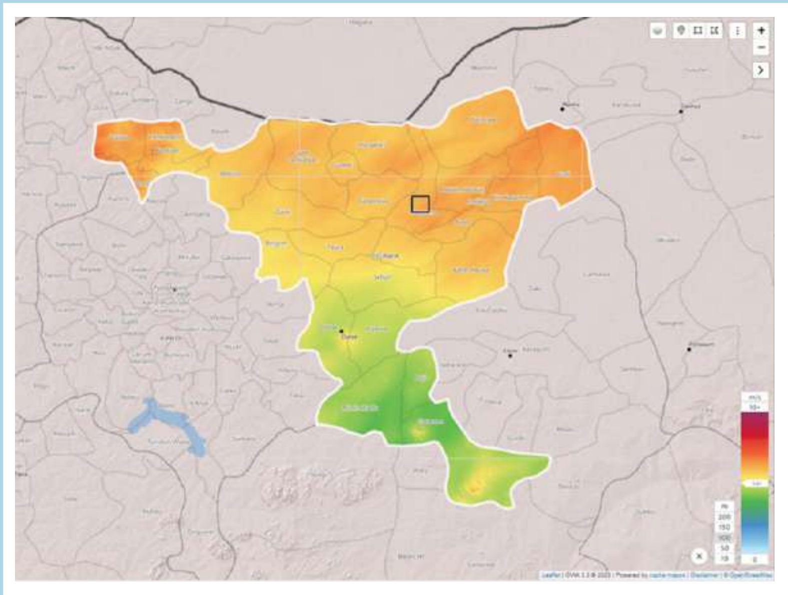
Power Generation Potential @ 50m, 100m and 150m Heights for North-West Nigeria

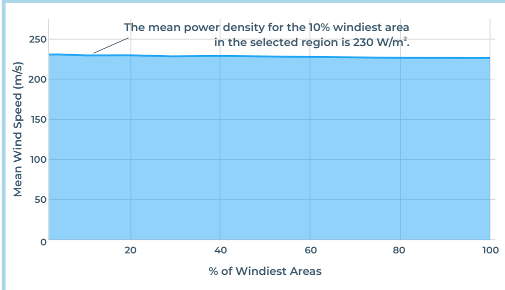


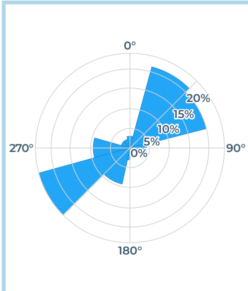
Jigawa State – Kaugama: This is situated in the northern part of Jigawa State, Nigeria, covers a land area of 883km^2

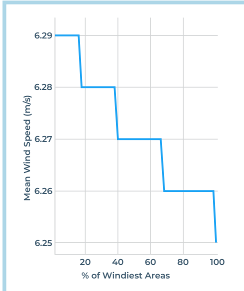
Kaugama, exhibits a relatively flat topography with elevations ranging from 356m to 370m above sea level, and an average elevation of 363m.

The state's northern, central, and eastern regions are characterized by undulating sand dunes running southwest to northeast, while areas around the state capital, Dutse, are rocky with low hills. The southern and western parts, around Birnin Kudu and Kazaure, have higher elevations with hills reaching up to 600m.

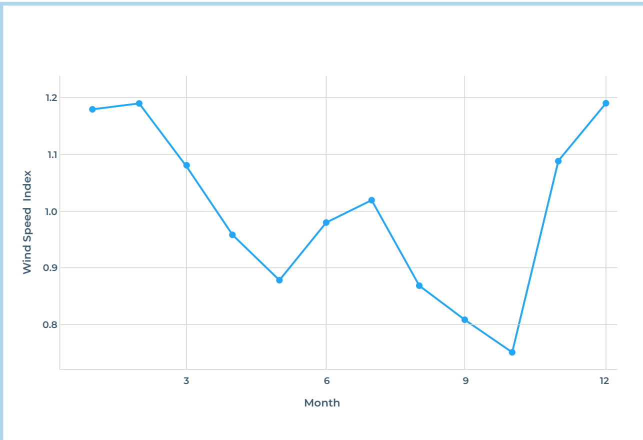


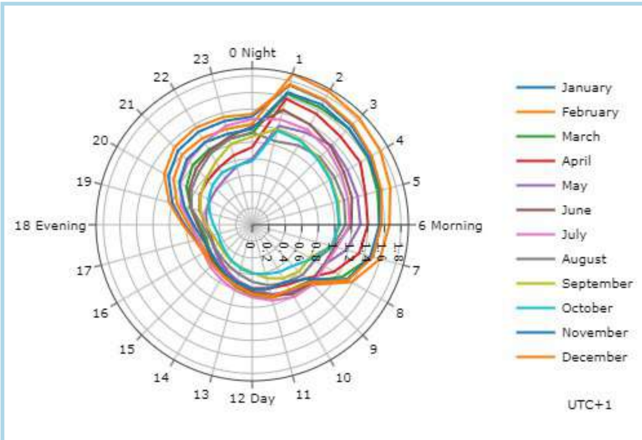






The wind rose diagram for Dabuwaran, Kaugama indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 6.29 m/s and mean power density of 230 W/m² at 10% of the windiest area.





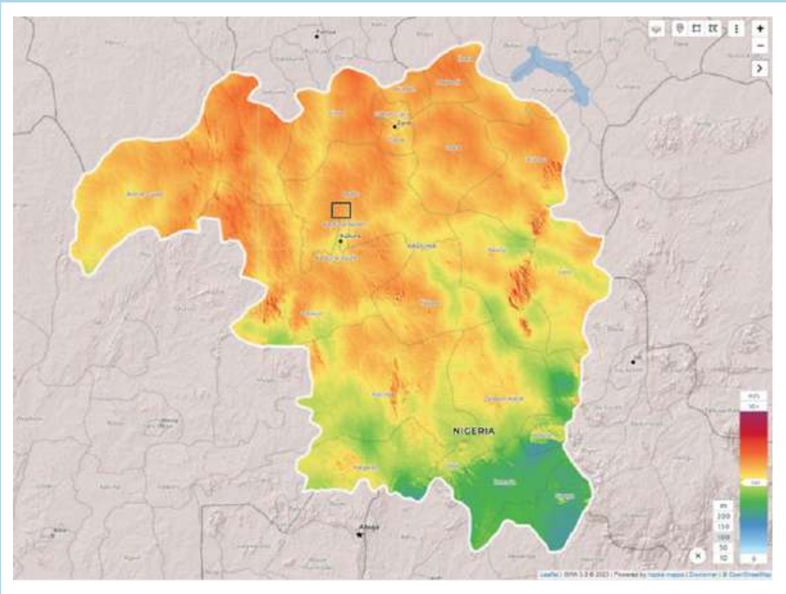
Kaugama's wind peaks in February and December at 7.49 m/s and is lowest in October at 4.72 m/s. At peak period, we generate up to 4.08MW with the low case generation capacity at 1.02MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

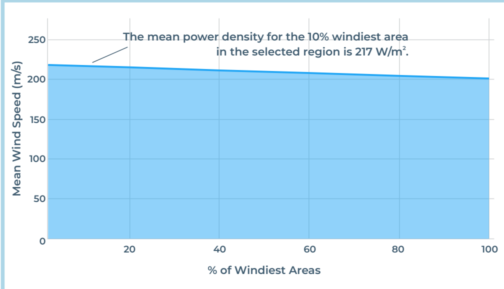
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
12.396379°, 9.762689°	Jigawa (North West)	Dabuwaran, Kaugama, Jigawa State	50m	5.29m/s	159W/m²
			100m	6.29m/s	230W/m²
			150m	7.48m/s	415W/m²

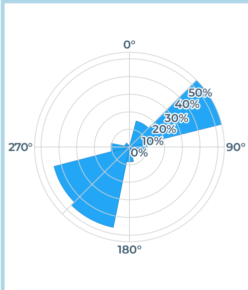
Kaduna State - Igabi: It is situated at an elevation of approximately 2,208ft (631m), Igabi features significant variations in elevation within a 2-mile radius, with changes up to 495ft.

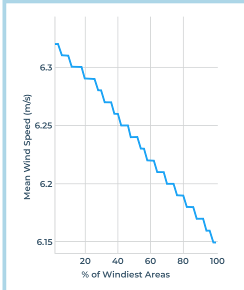
Based on the Rural Land Consumption Rate (RLCR) and Absorption Coefficient which were computed, the change analysis revealed that 83.3% of the total farmland were rendered barren, 8.5% became distorted vegetation, while 8.2% were consumed by the growing settlement.

This diverse topography and land use influence local wind patterns, which potentially affect the wind speed and direction.

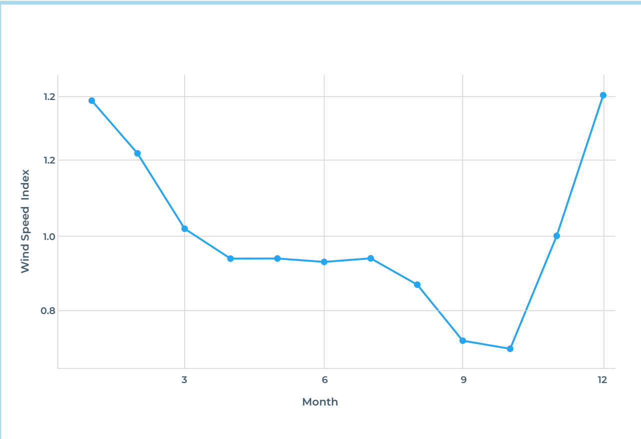


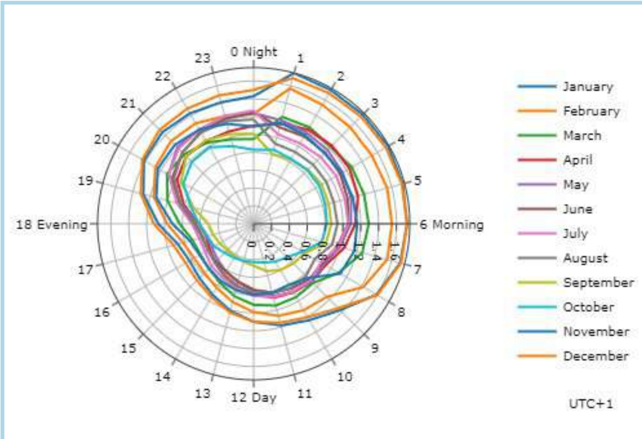






The wind rose diagram for Igabi indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 6.31 m/s and mean power density of 217 W/m² at 10% of the windiest area.



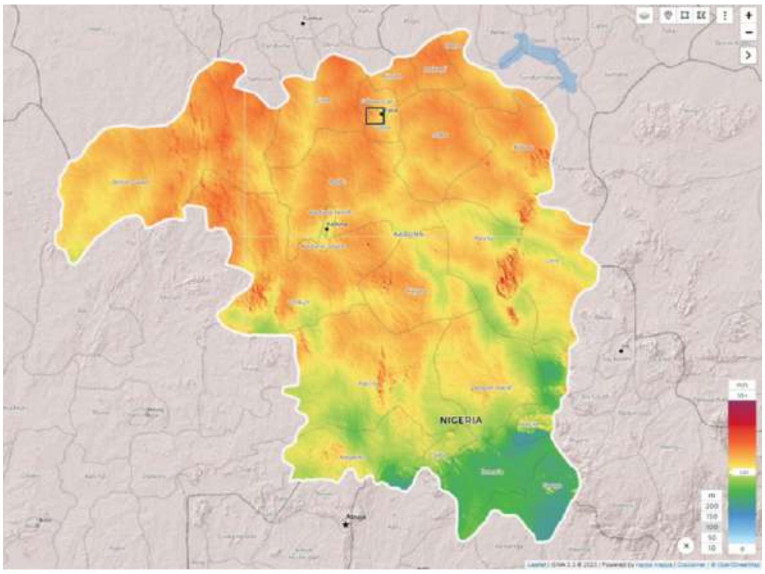


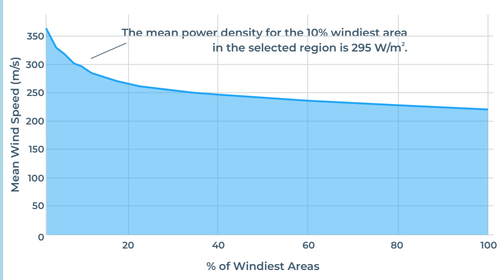
The wind speed in Igabi peaks in January and December at 8.71 m/s and is lowest in October at 4.42 m/s. At peak period, we generate up to 6.41MW with the low case generation capacity at 0.84MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

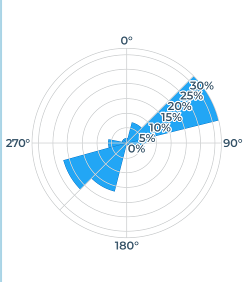
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
10.662632°, 7.453537°	Kaduna (North West)	Rigachikun, Igabi, Kaduna State	50m	5.29m/s	144W/m²
			100m	6.31m/s	217W/m²
			150m	7.19m/s	347W/m²

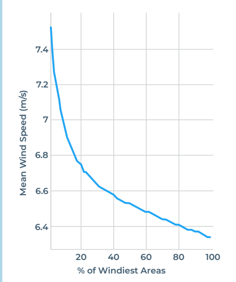
Kaduna State - Zaria: It is located at an elevation of 686m, Zaria experiences a tropical savanna climate. Wind patterns are influenced by seasonal shifts: the north-easterly winds dominate from November to February, associated with the dry Harmattan season, while south-westerly winds prevail from May to September, bringing the rainy season.

Studies have recorded maximum wind speeds of 3 m/s at a height of 10m above ground. The available wind power in the area was 16.46 w/s-2 but the maximum average extractable wind power per unit area was 9.76 w/m^2.

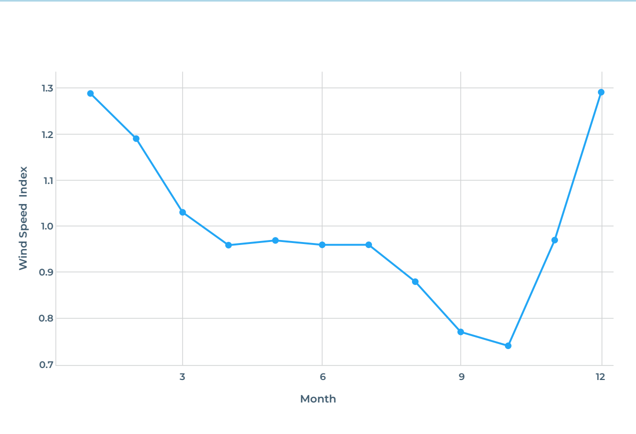


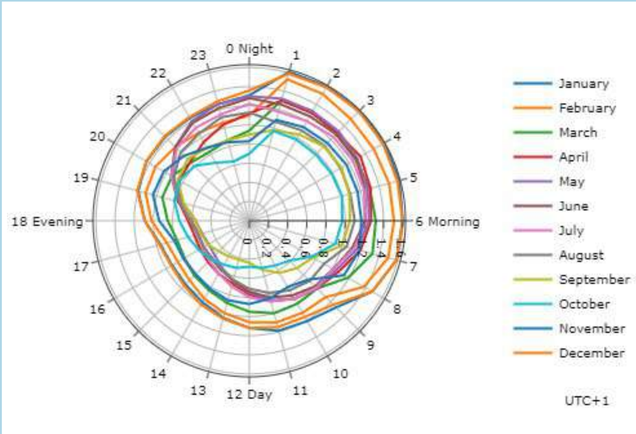






The wind rose diagram for our location in Zaria indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 6.99 m/s and mean power density of 295 W/m² at 10% of the windiest area.



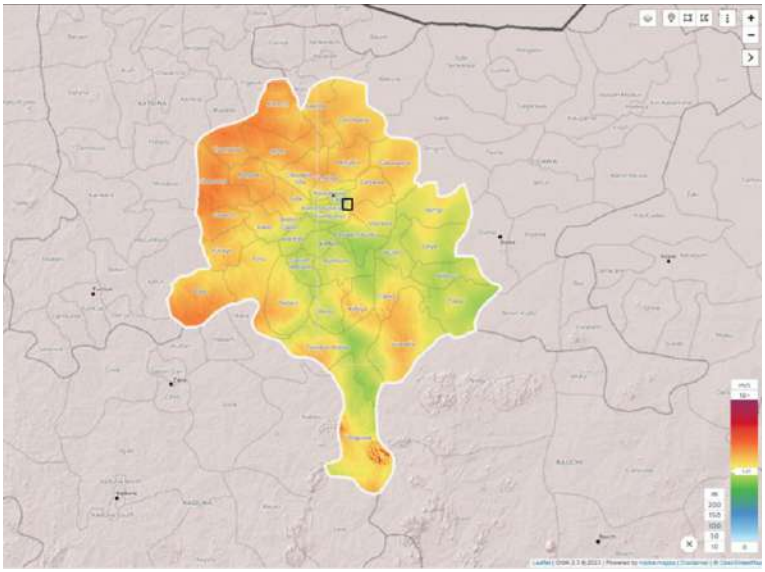


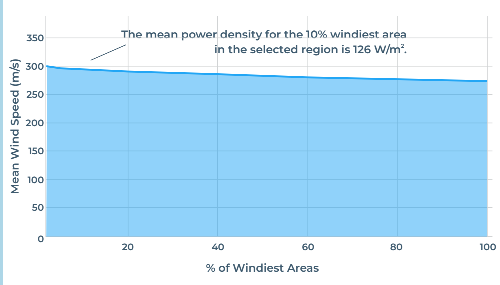
The wind speed in Zaria peaks in January and December at 9.02 m/s and is lowest in October at 5.17 m/s. At peak period, we generate up to 7.02MW with the low case generation capacity at 1.34MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

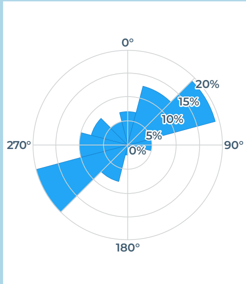
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
11.089808°, 7.657127°	Kaduna (North West)	Kufena, Zaria, Kaduna State	50m	6.12m/s	227W/m²
			100m	6.99m/s	295W/m²
			150m	7.87m/s	451W/m²

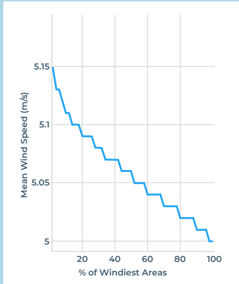
Kano State - Northern Nigeria Flour Mills: This area features a relatively flat terrain with elevations around 493m. The climate is tropical savanna, with average annual temperatures ranging from 56°F to 101°F. Wind speeds vary throughout the year, averaging between 9km/h in September and 12.4km/h in June. The region experiences a wet season dominated by the tropical maritime air mass, and a dry season influenced by the Harmattan winds.

These climatic factors, combined with the area's topography, influence local wind patterns. Studies indicate that Kano has a significant wind power density.

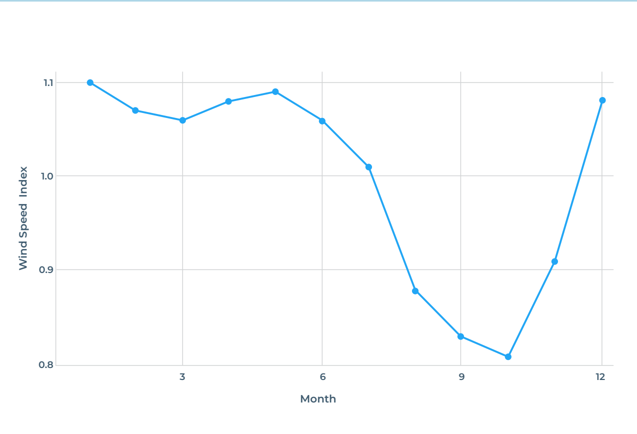


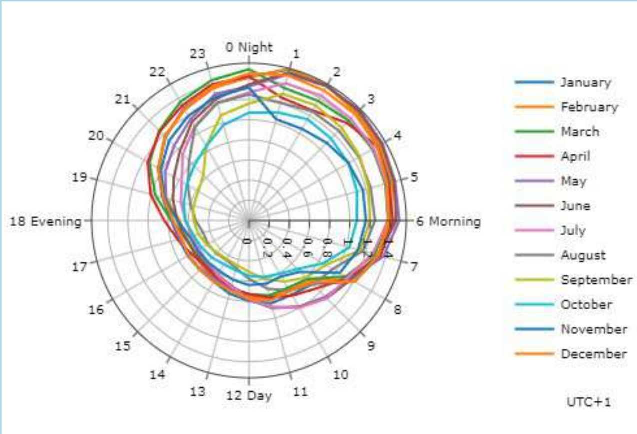






The wind rose diagram for our location in Northern Nigeria flour mills indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 5.10 m/s and mean power density of 126 W/m² at 10% of the windiest area.



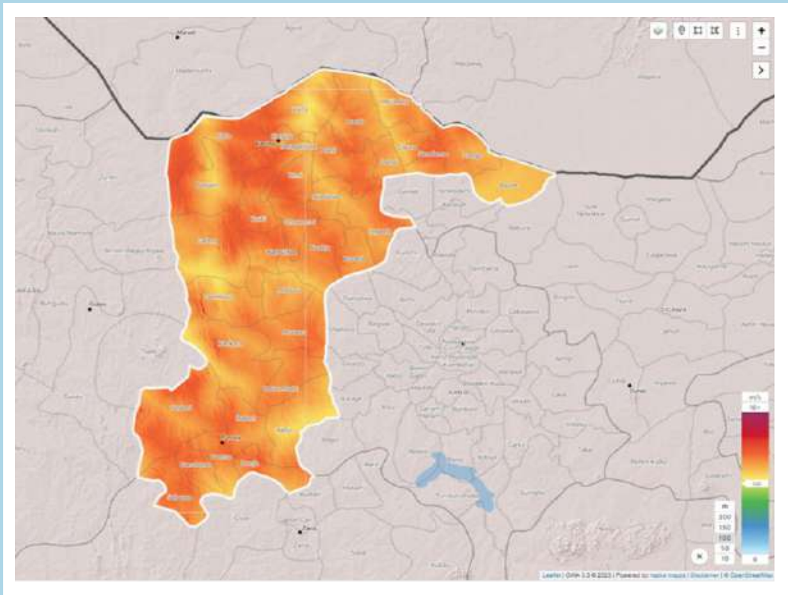


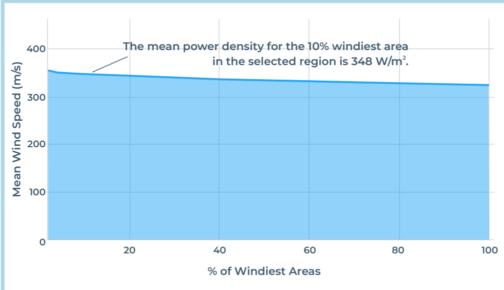
The wind speed in Kano flour mills peaks in January at 5.61 m/s and is lowest in October at 4.13 m/s. At peak period, we generate up to 1.71MW with the low case generation capacity at 0.68MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

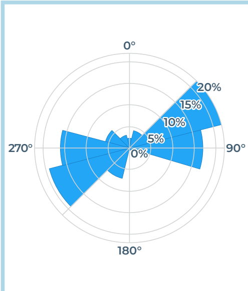
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
12°01'23"N, 8°33'49"E	Kano (North West)	Northern Nigeria Flour mill, Kano State	50m	4.03m/s	72W/m²
			100m	5.10m/s	126W/m²
			150m	6.28m/s	247W/m²

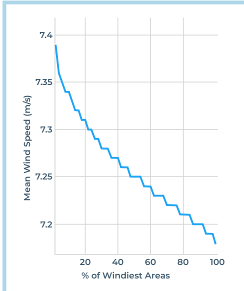
Katsina State – Batagarawa: It is situated at an elevation of approximately 526m. The area experiences average wind speeds that vary throughout the year, with a the windiest being 17km/h in January. The region's semi-arid climate leads to low humidity levels during the dry season months of February and March.

These climatic conditions suggest a semi-arid environment. Studies have indicated that Katsina State falls under Class 7 of the international wind classification system.

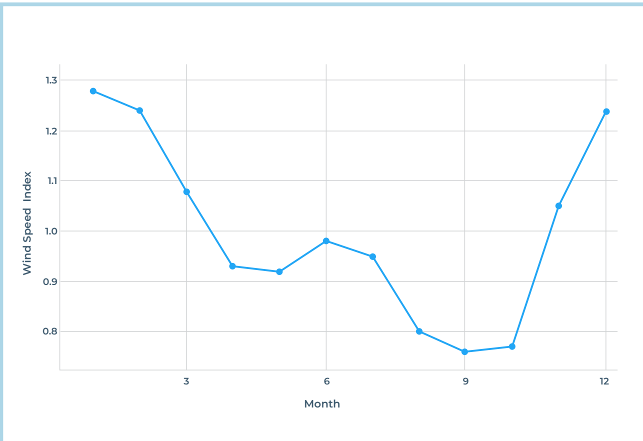


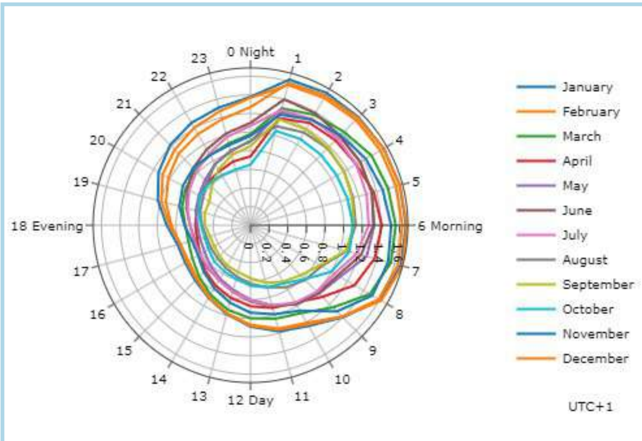






The wind rose diagram for our location in Batagarawa indicates the wind blowing predominantly from the Northeast and Southwest directions with a smaller proportion blowing from the East and West at a mean wind speed of 7.34 m/s and mean power density of 348 W/m² at 10% of the windiest area.



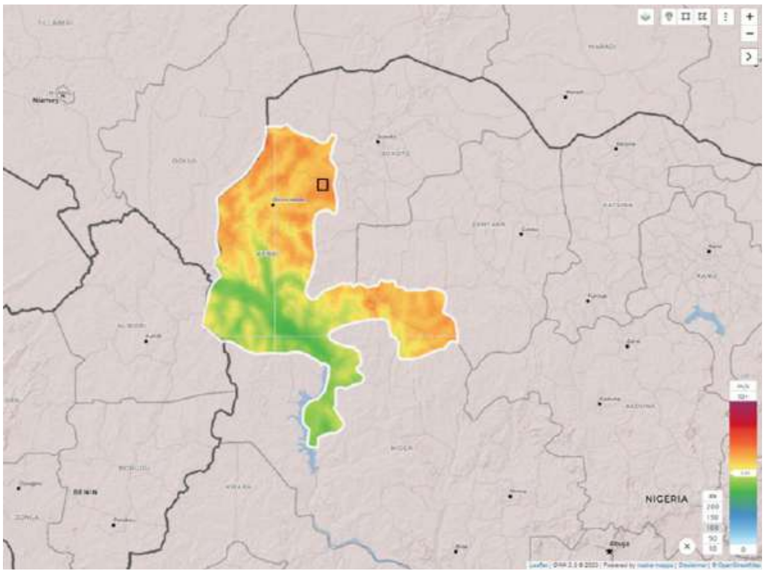


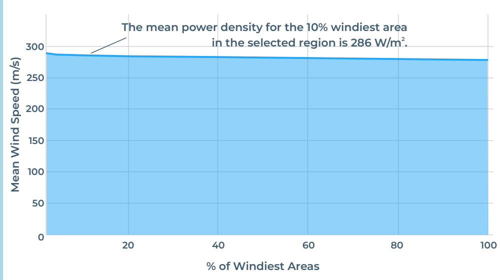
Batagarawa's wind speed peaks in January at 9.47 m/s and is lowest in October at 5.58 m/s. At peak period, we generate up to 8.24MW with the low case generation capacity at 1.68MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

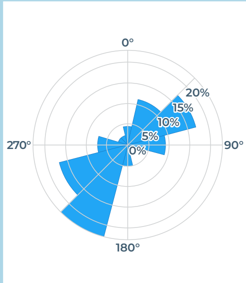
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
12.9114891°, 7.559888°	Katsina (North West)	Jino, Batagarawa, Katsina State	50m	6.16m/s	232W/m²
			100m	7.34m/s	348W/m²
			150m	8.39m/s	548W/m²

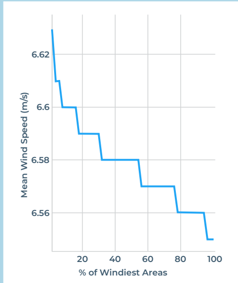
Kebbi State – Gwandu: Gwandu is a historic town located near a branch of the Zamfara River, a tributary of the Sokoto River. The town serves as a collecting point for agricultural products such as peanuts, tobacco, and rice, and functions as a major local market centre for millet, sorghum, onions, bananas, cotton, goats, cattle, skins, and kola nuts.

The proximity to the river influences local wind patterns and microclimatic conditions.

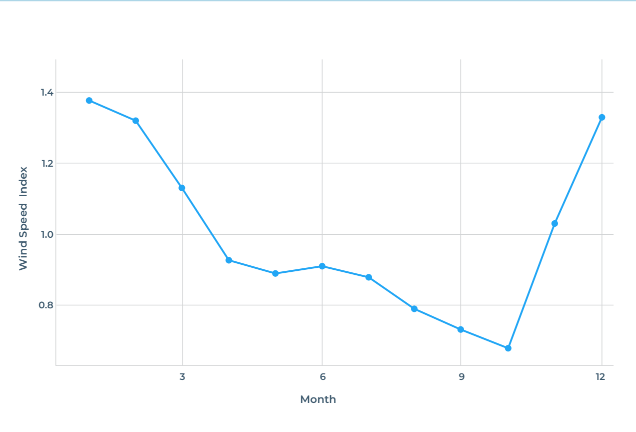


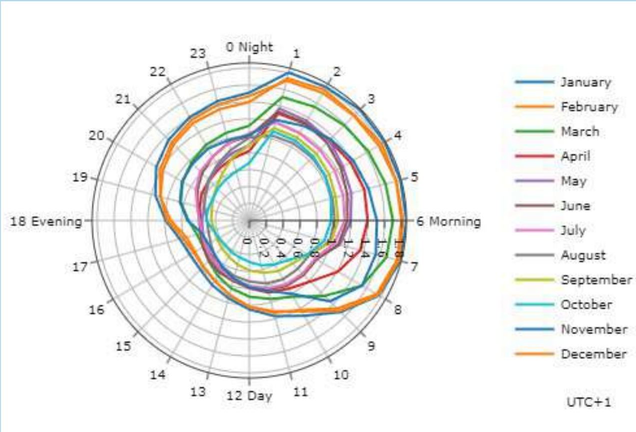






The wind rose diagram for our location in Gwandu indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 6.6 m/s and mean power density of 286 W/m² at 10% of the windiest area.



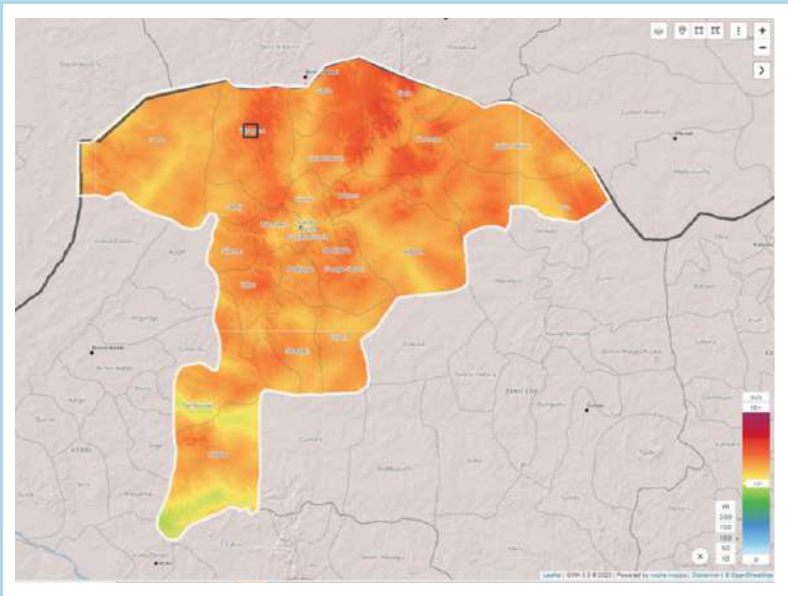


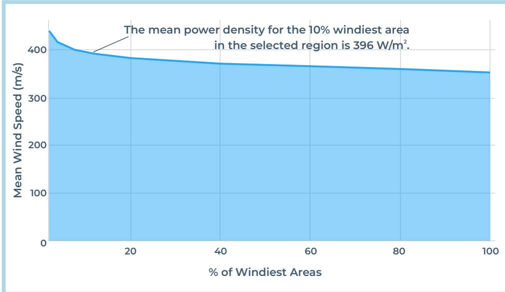
Birnin Kebbi's wind speed peaks in January at 9.17 m/s and is lowest in October at 4.29 m/s. At peak period, we generate up to 7.48MW with the low case generation capacity at 0.77MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

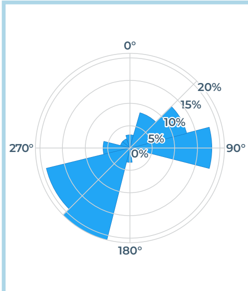
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
12.582265°, 4.749374°	Kebbi (North West)	Maruda, Gwandu, Kebbi State	50m	5.54m/s	193W/m²
			100m	6.6m/s	286W/m²
			150m	7.54m/s	459W/m²

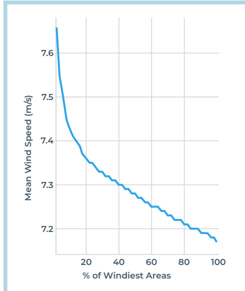
Sokoto State – Tangaza: Tangaza Local Government Area (LGA) spans 2,477 km² with a population of about 198,100 as of 2022. Located in Sokoto State, Nigeria, it borders the Republic of Niger to the north.

The region features a semi-arid landscape with an average elevation of 294m, predominantly flat terrain, and isolated hills typical of the Sahel region. The climate is semi-arid, with an average temperature of 34°C and annual precipitation of 1,150 mm.

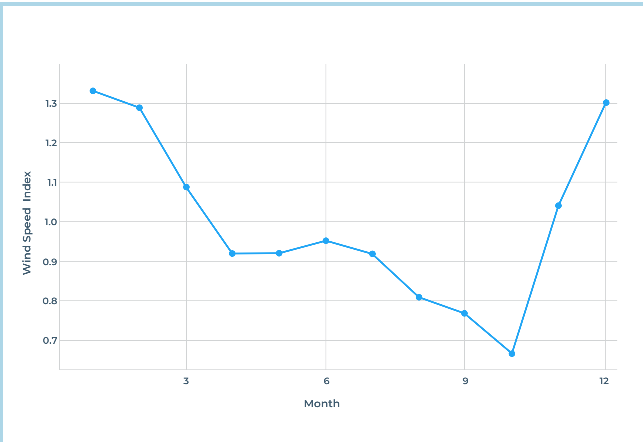


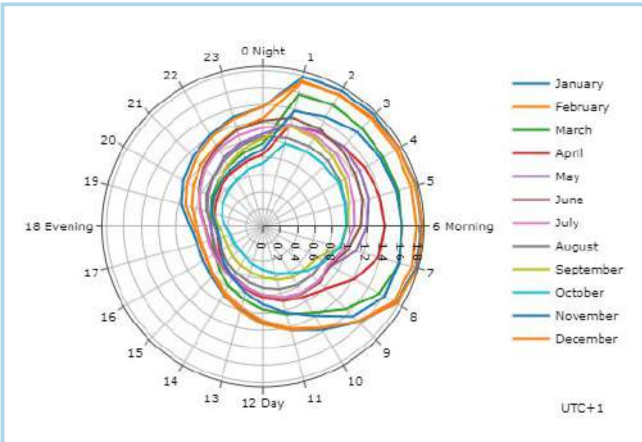






The wind rose diagram for our location in Tangaza indicates the wind blowing predominantly from the East and Southwest directions at a mean wind speed of 7.43 m/s and mean power density of 396 W/m² at 10% of the windiest area.





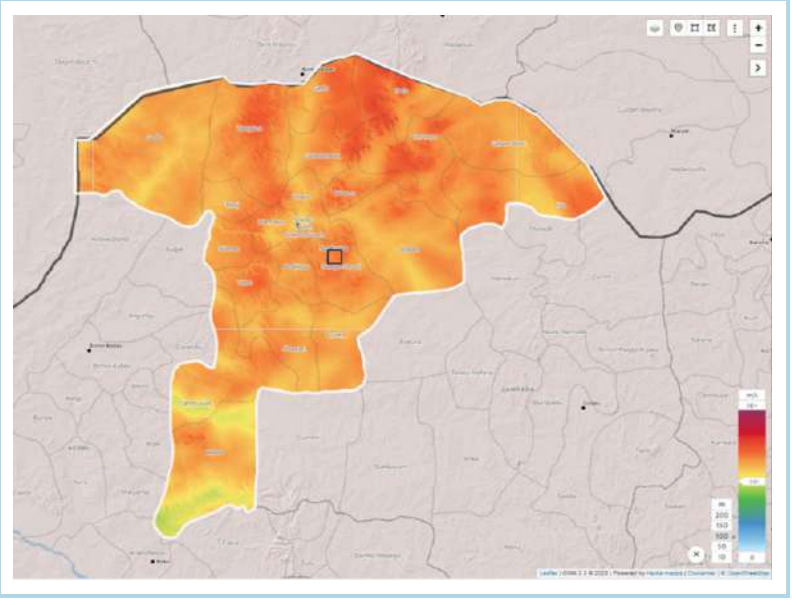
Tangaza's wind speed peaks in January at 10.03 m/s and is lowest in October at 4.98 m/s. At peak period, we generate up to 9.79MW with the low case generation capacity at 1.20MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

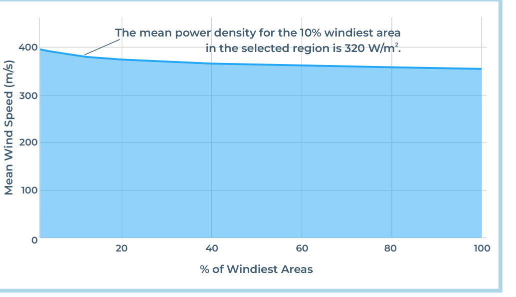
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
13.53386°, 5.018005°	Sokoto (North West)	Magonho, Tangaza, Sokoto State	50m	6.43m/s	294W/m²
			100m	7.43m/s	396W/m²
			150m	8.27m/s	593W/m²

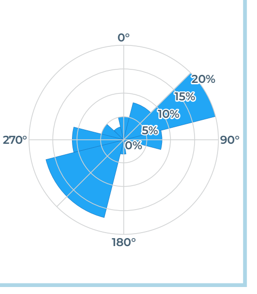
Sokoto State – Dange Shuni: This area spans 1,210km² with an estimated population of 333,900 as of 2022. It includes towns and villages like Shuni, Hausawa Maiwa, Tudun-Yando, and Rikina.

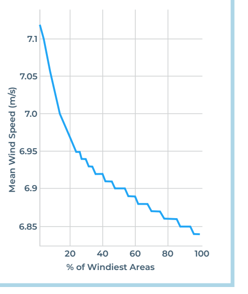
The region's topography averages 296m above sea level, featuring predominantly flat terrain with gentle undulations typical of Northwestern Nigeria's semi-arid landscapes.

Dange Shuni has a semi-arid climate with two distinct seasons: a cloudy wet season from May to October, and a hot, partly cloudy dry season. Temperatures range from 17°C to 39°C, rarely falling below 14°C or rising above 42°C.

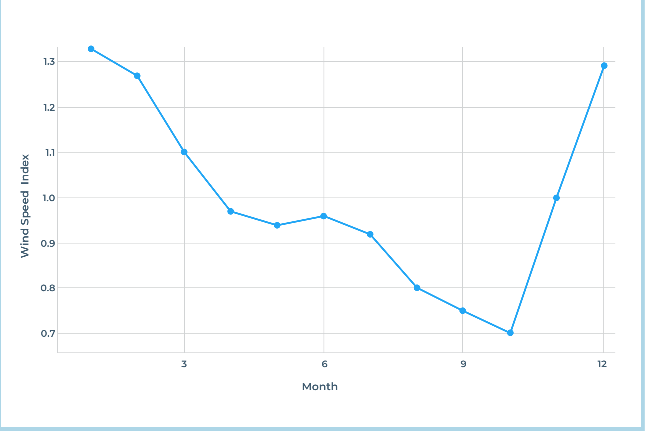


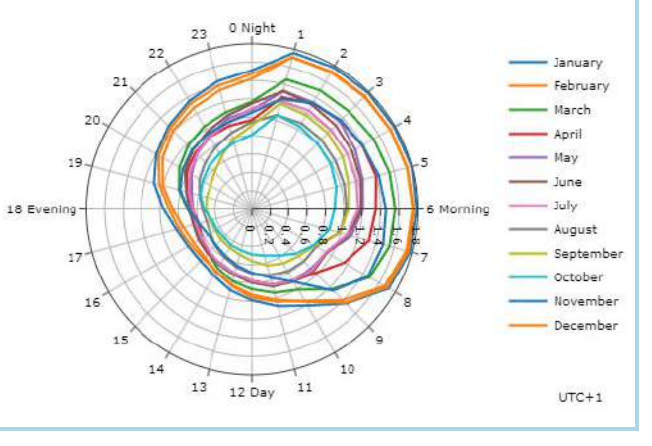






The wind rose diagram for our location in Dange Shuni indicates the wind blowing predominantly from the East and Southwest directions at a mean wind speed of 7.04 m/s and mean power density of 320 W/m² at 10% of the windiest area.





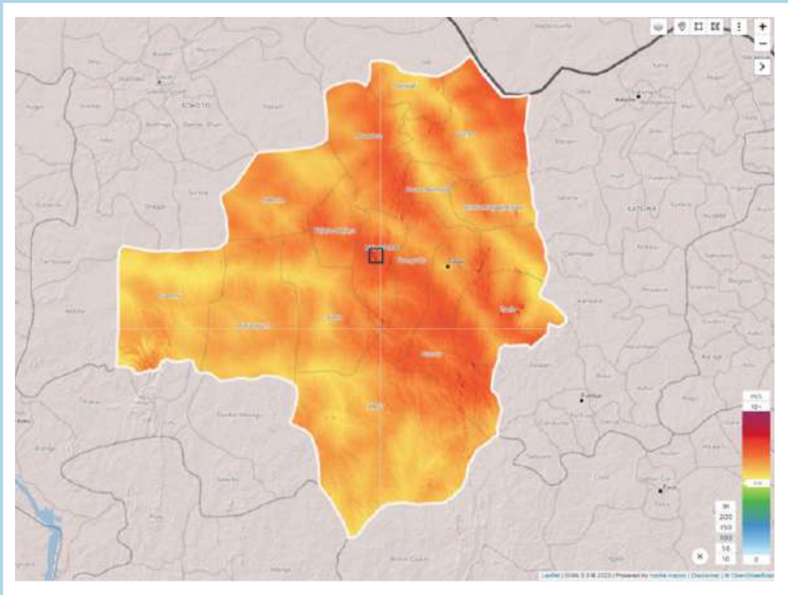
Dange Shuni's wind speed peaks in January at 9.50 m/s and is lowest in October at 4.93 m/s. At peak period, we generate up to 8.32MW with the low case generation capacity at 1.16MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

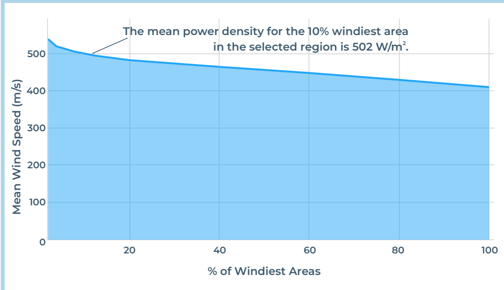
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
12.843938°, 5.39978°	Sokoto (North West)	Fagaldu, Dange-Shuni, Sokoto State	50m	5.93m/s	217W/m²
			100m	7.04m/s	320W/m²
			150m	8.01m/s	508W/m²

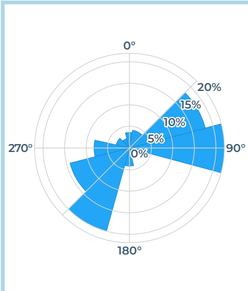
Zamfara State – Kanoma Maru: It is located near the villages of Ashar Lafia and Mahuta, featuring a hilly landscape with Kanoma Hill reaching about 500 meters. The terrain includes rocky outcrops and undulating plains.

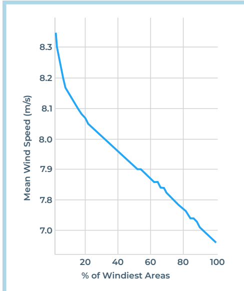
The region experiences moderate rainfall during the wet season and has no significant flood risk.

Kanoma is a rural agricultural settlement, with most residents engaged in farming and livestock rearing. The area is covered with savanna grasslands and scattered trees, reflecting minimal urban development.

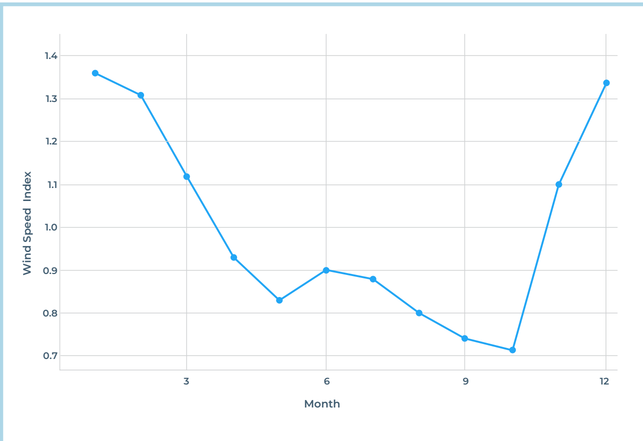


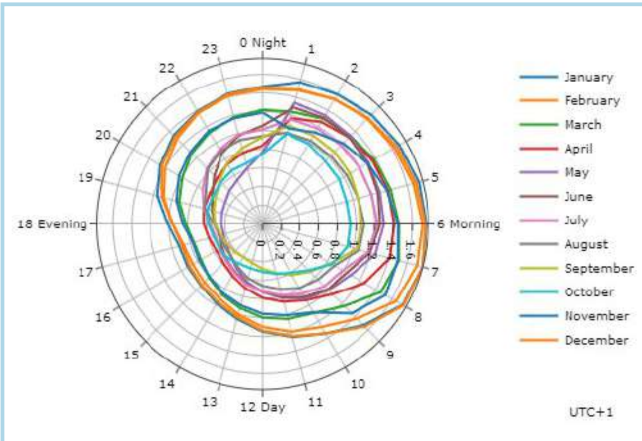






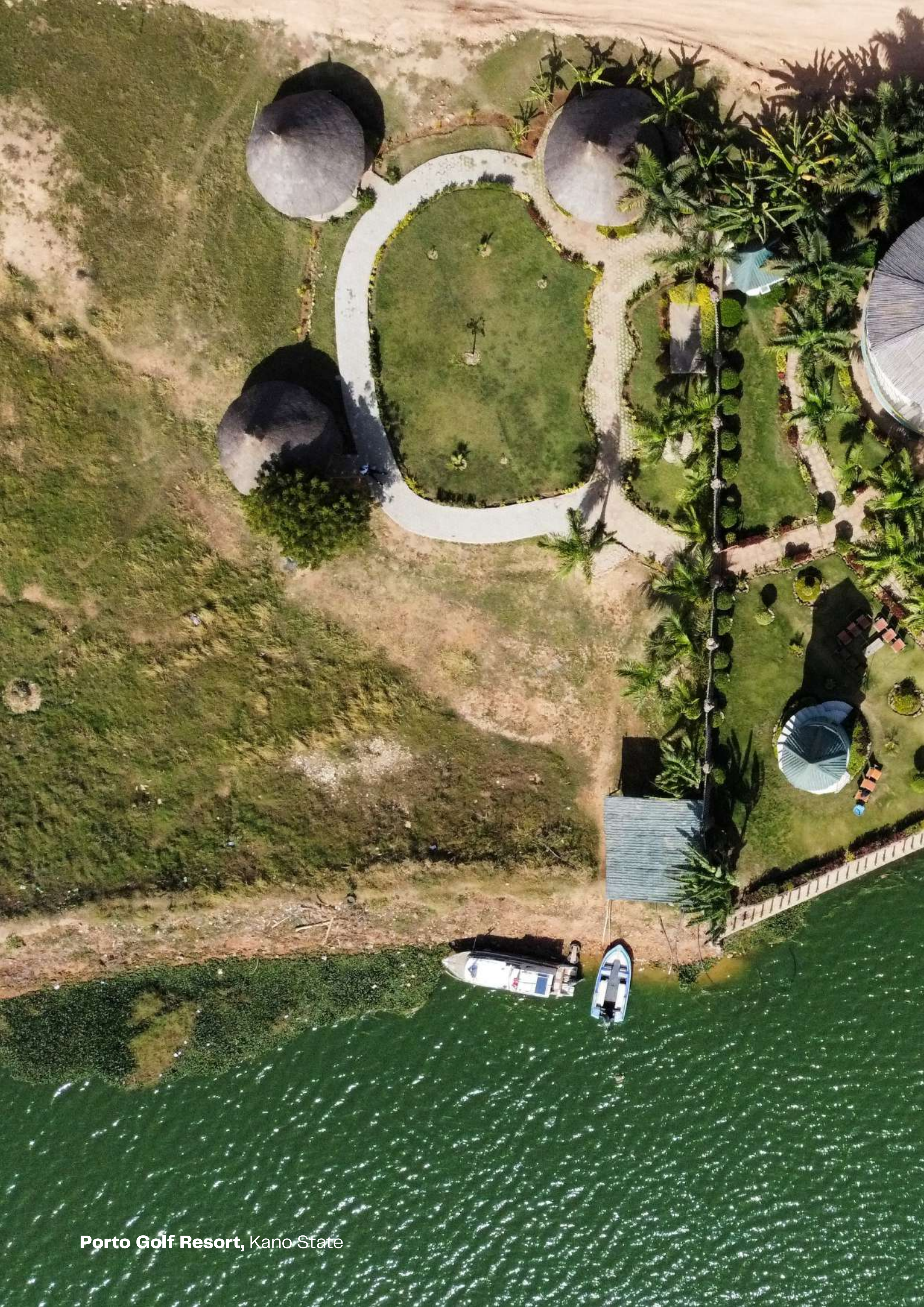
The wind rose diagram for our location in Kanoma Maru indicates the wind blowing predominantly from the East and Southwest directions at a mean wind speed of 8.15 m/s and mean power density of 502 W/m² at 10% of the windiest area.





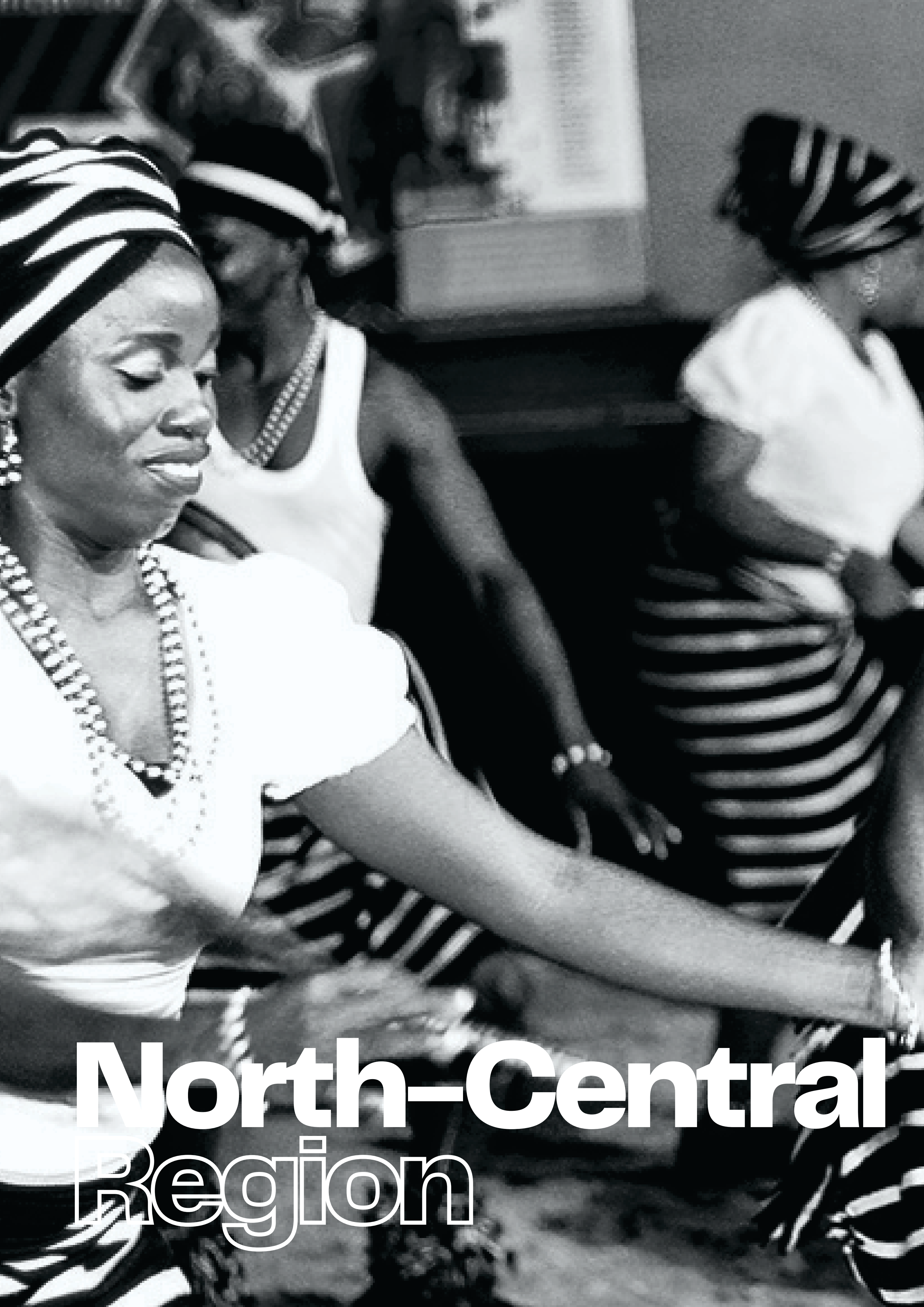
Kanoma Maru's wind speed peaks in January at 11.25 m/s and is lowest in October at 5.87 m/s. At peak period, we generate up to 13.81MW with the low case generation capacity at 1.96MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
12.235339°, 6.297913°	Zamfara (North West)	Kanoma Maru, Zamfara State	50m	7.12m/s	374W/m²
			100m	8.15m/s	502W/m²
			150m	9.06m/s	722W/m²



Porto Golf Resort, Kano State

North–Central Region



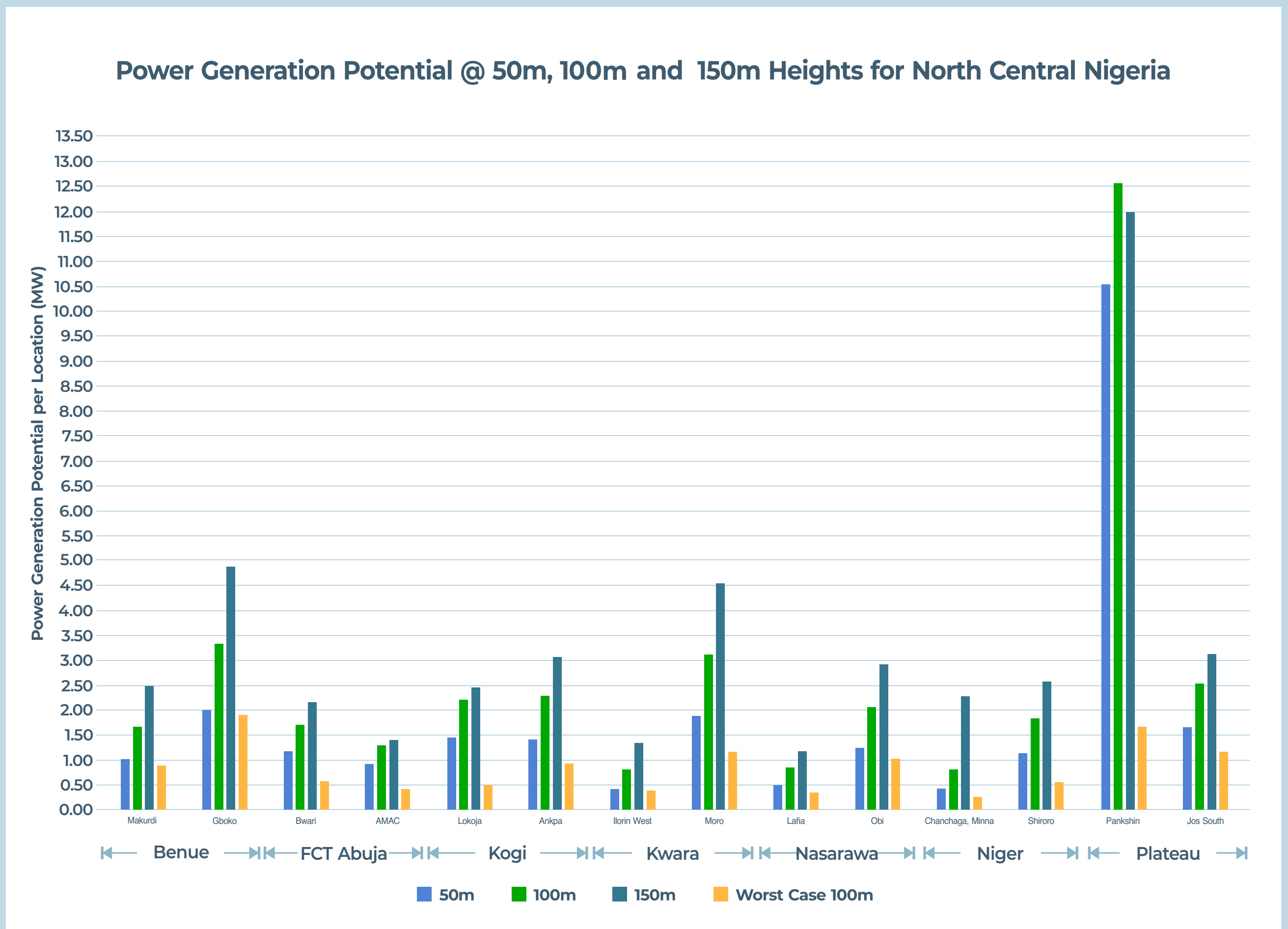
North-Central Region

States: Benue, FCT Abuja, Kogi, Kwara, Nasarawa, Niger and Plateau.

Summary: The North central region of Nigeria is home to about 20 million people and is comprised of 6 states and the Federal Capital Territory, Abuja. Otherwise known as the middle belt, the regions stretches across the country longitudinally covering an area of 242,425 km².

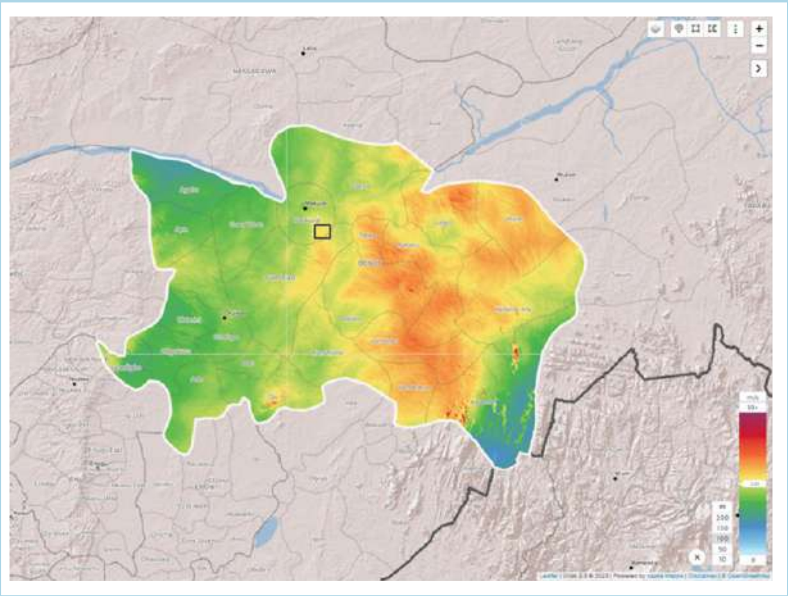
About 47% of the region has no access to electricity, despite the states therein having fantastic wind energy potential, with Plateau state having potentially the best wind speed in the entire country with speeds of up to 10.9 m/s.

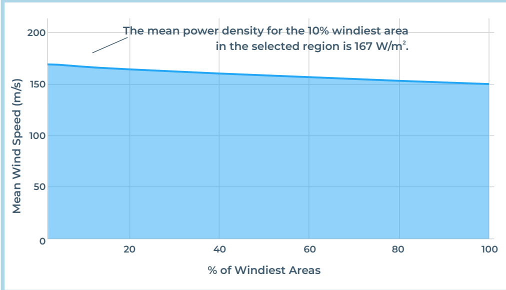
Wind Power Potential											
			50m		100m		150m		Worst Case Scenario		
State	Location	Coordinates	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Month
Benue	Makurdi	7.64703°, 8.58994°	4.71	1.01	5.56	1.67	6.35	2.48	4.50	0.89	November
	Gboko	7.38153°, 8.99059°	5.90	1.99	7.00	3.33	7.95	4.87	5.81	1.90	October
FCT, Abuja	Bwari	9.255292°, 7.40711°	4.96	1.18	5.58	1.69	6.06	2.16	3.91	0.58	October
	AMAC	8.781713°, 7.495015°	4.58	0.93	5.11	1.29	5.26	1.41	3.53	0.43	October, November
Kogi	Lokoja	8.036114°, 6.651859°	5.32	1.46	6.11	2.21	6.34	2.47	3.67	0.48	December
	Ankpa	7.552194°, 7.653382°	5.27	1.42	6.18	2.29	6.8	3.05	4.57	0.93	December
Kwara	Ilorin West	8.440111°, 4.555893°	3.54	0.43	4.34	0.79	5.17	1.34	3.34	0.36	December
	Moro	8.711359°, 4.695282°	5.79	1.88	6.84	3.10	7.77	4.55	4.92	1.316	December
Nasarawa	Lafia	8.431621°, 8.538333°	3.73	0.50	4.43	0.84	4.95	1.18	3.28	0.34	November
	Obi	8.324817°, 8.91807°	5.04	1.24	5.96	2.05	6.7	2.92	4.71	1.01	October
Niger	Chanchaga, Minna	9.583824°, 6.547165°	3.56	0.44	4.37	0.81	6.17	2.28	2.97	0.25	October
	Shiroro	9.583824°, 6.547165°	4.88	1.13	5.73	1.82	6.44	2.59	3.90	0.57	October
Plateau	Pankshin	9.14413°, 9.673116°	10.28	10.54	10.90	12.56	10.74	12.02	5.56	1.67	October
	Jos South	9.695586°, 8.73447°	5.54	1.65	6.39	2.53	6.85	3.12	4.92	1.16	Septmeber

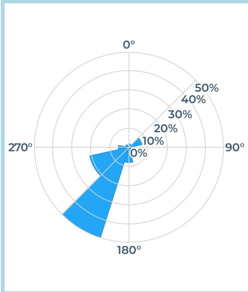


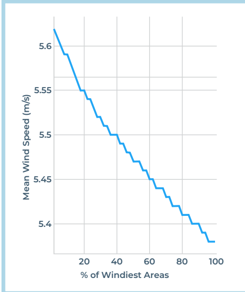
Benue State - Makurdi: This location serves as the administrative and commercial hub of a largely savanna region. With elevations ranging from 70m to 163m, its gently rolling terrain creates distinct microclimatic conditions that influence local wind dynamics.

The city's hydrological network, fueled by seasonal rainfall and winding streams, regulates airflow and moisture distribution alongside the dominant savanna vegetation. A harmonious blend of urban development and rural heritage is reflected in the coexistence of modern infrastructure and traditional agricultural practices.

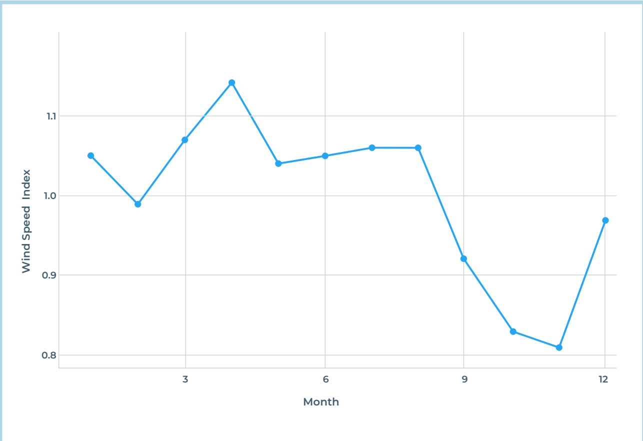


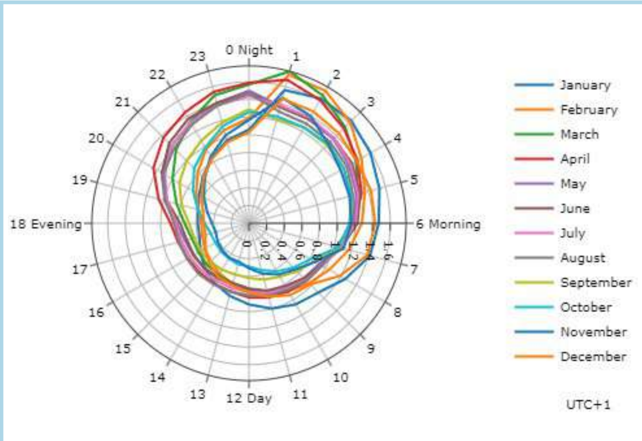






The wind rose diagram for Makurdi indicates the wind blowing predominantly from the Southwest at a mean wind speed of 5.56 m/s and mean power density of 167 W/m² at 10% of the windiest area.



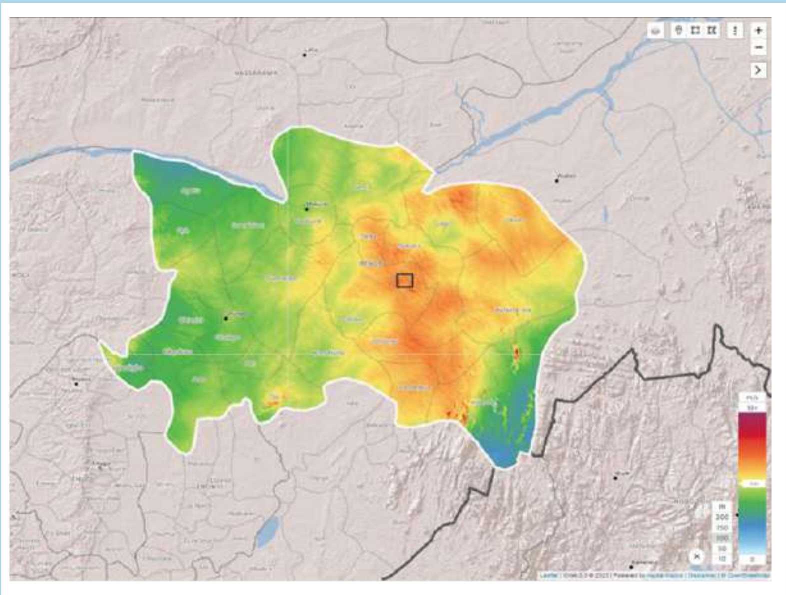


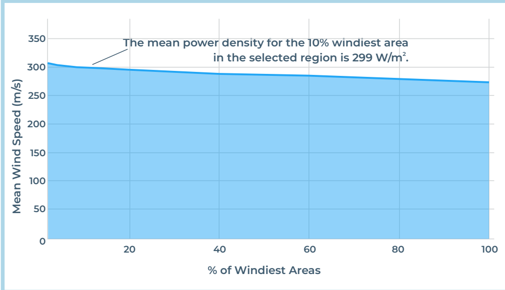
Makurdi's wind speed peaks in April at 6.51 m/s and is lowest in November at 4.50 m/s. At peak period, we generate up to 2.68MW with the low case generation capacity at 0.89MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

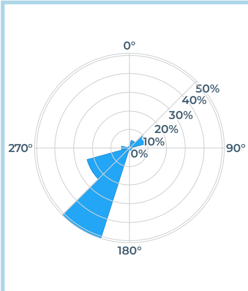
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
7.64703°, 8.58994°	Benue (North Central)	Makurdi, Benue State	50m	4.73m/s	114W/m²
			100m	5.59m/s	167W/m²
			150m	6.38m/s	254W/m²

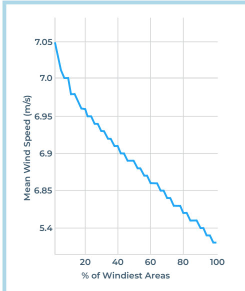
Benue State - Gboko: This is located in the expansive savanna of Benue State, Gboko is a prominent urban center serving as a vibrant local hub amid primarily rural surroundings. Gboko's landscape features a dynamic elevation range of 236ft to 1,539ft.

This variability, along with seasonal rainfall and simple drainage systems, affects local wind behavior by altering surface roughness through sporadic trees and grasslands. Agriculture and trade drive Gboko's economy, supported by new urban infrastructure that blends with the natural savanna setting.

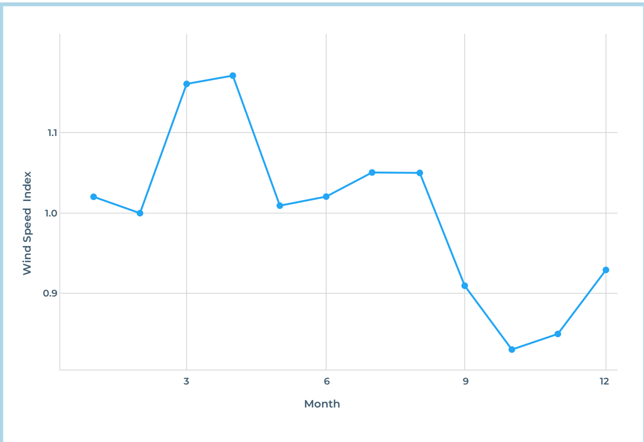


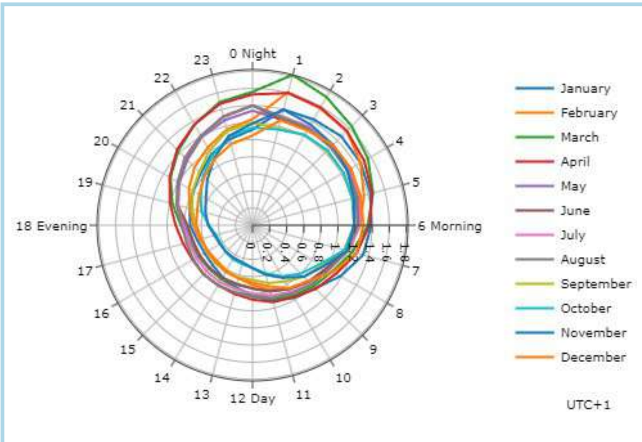






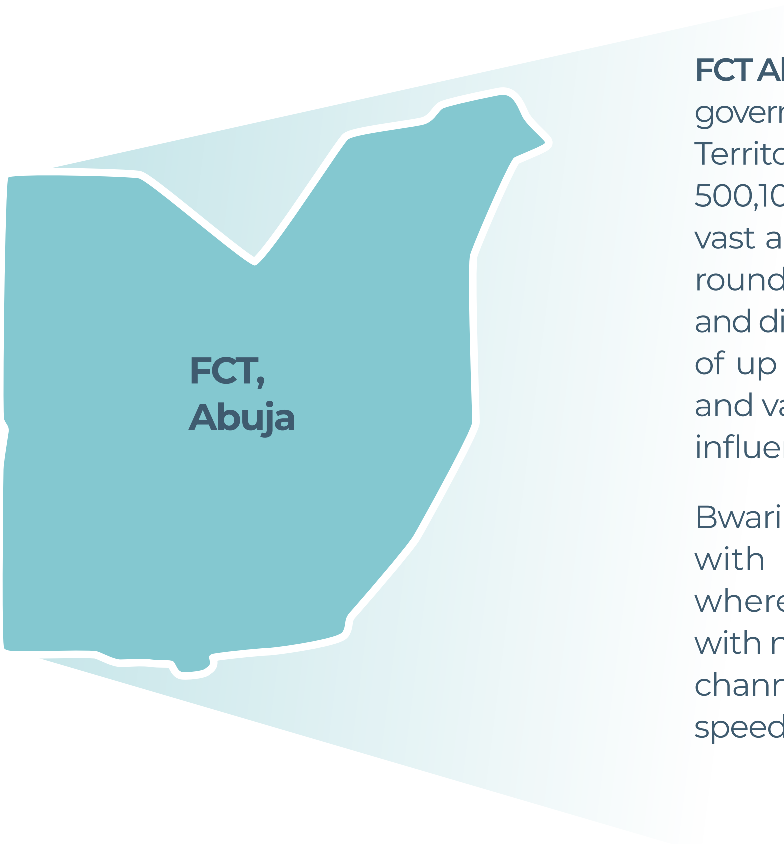
The wind rose diagram for Gboko indicates the wind blowing predominantly from the Southwest at a mean wind speed of 7.00 m/s and mean power density of 299 W/m² at 10% of the windiest area.





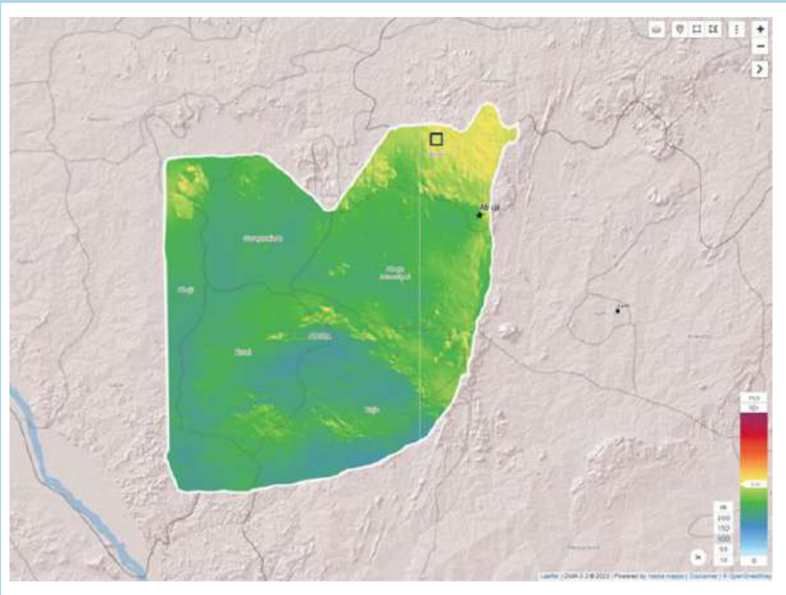
Gboko's wind speed peaks in April at 8.26 m/s and is lowest in November at 5.81 m/s. At peak period, we generate up to 5.47MW with the low case generation capacity at 1.90MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

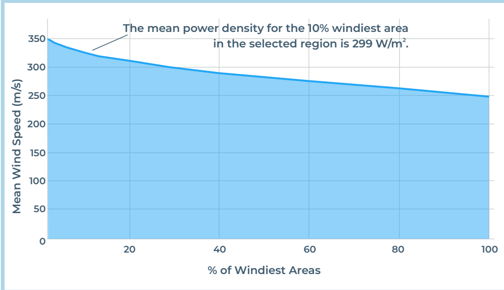
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
7.38153°, 8.99059°	Benue (North Central)	Gboko, Benue State	50m	5.9m/s	200W/m²
			100m	7m/s	299W/m²
			150m	7.95m/s	451W/m²

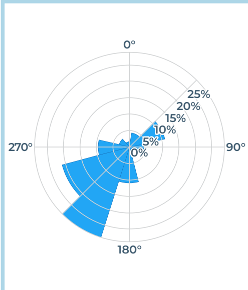


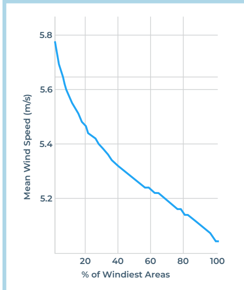
FCT Abuja – Bwari: This is a a 1,031 km² local government area in the Federal Capital Territory, is inhabited by approximately 500,100 people (2022 projection). This vast area, characterized by rolling plains, rounded hills, noticeable rock outcrops, and divided river valleys, reaches elevations of up to 838.1m. Its undulating surfaces and varying slope gradients significantly influence local wind dynamics.

Bwari blends modern urban planning with traditional settlement patterns, where infrastructure projects coexist with native vegetation and natural water channels that control wind direction and speed, creating a dynamic microclimate.

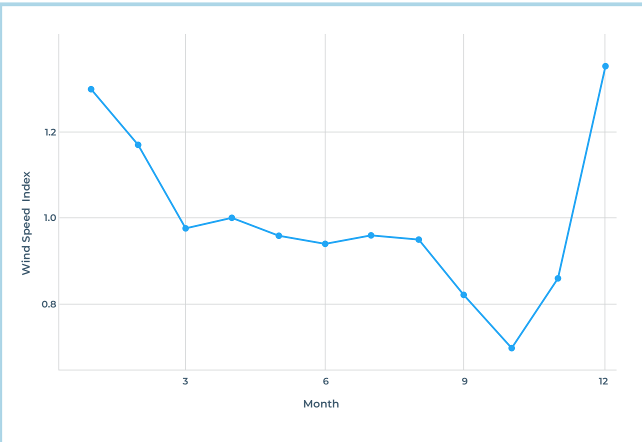


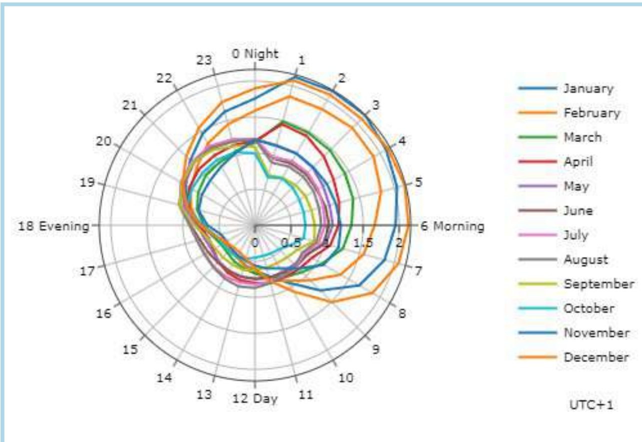






The wind rose diagram for Bwari indicates the wind blowing predominantly from the Southwest at a little percentage from the Northwest and Western directions at a mean wind speed of 5.58 m/s and mean power density of 233 W/m² at 10% of the windiest area.



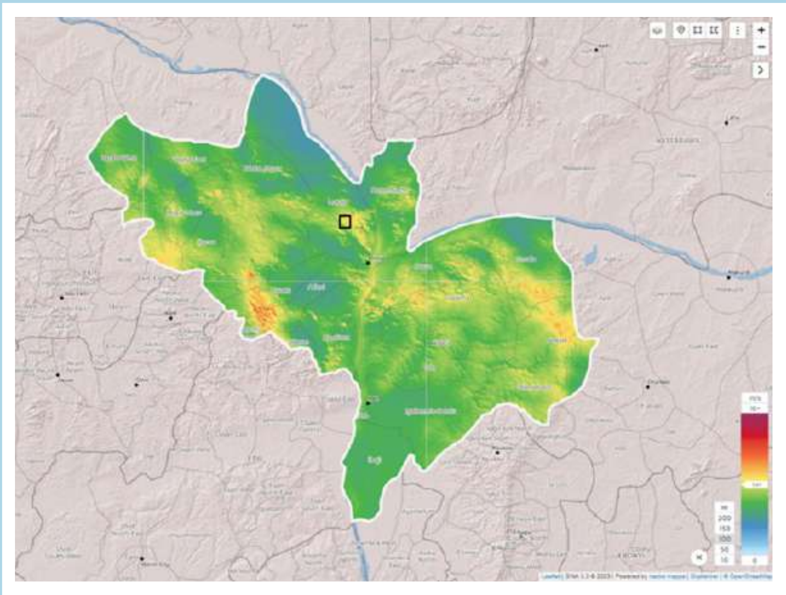


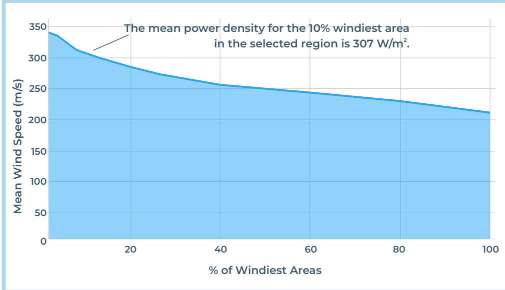
The wind speed in Bwari peaks in December at 7.53 m/s and is lowest in October at 3.90 m/s. At peak period, we generate up to 4.14MW with the low case generation capacity at 0.58MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

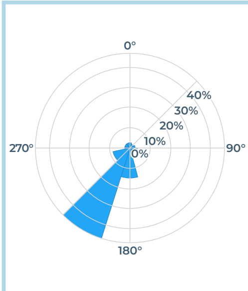
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
9.255292°, 7.40711°	FCT Abuja (North Central)	Bwari, Federal Capital Territory	50m	4.96m/s	186W/m²
			100m	5.58m/s	233W/m²
			150m	6.06m/s	291W/m²

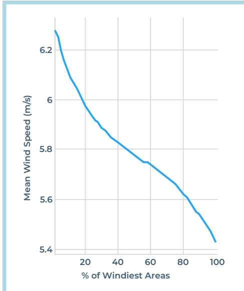
Kogi State - Lokoja: The capital of Kogi State is uniquely positioned at the confluence of the Niger and Benue rivers. This strategic location contributes to a tropical wet and dry savanna climate, characterized by distinct seasonal variations that influence local weather patterns. The adjacent plain along the Niger River and the presence of Mount Patti, which reaches up to 400m, create a topographic setting that significantly affects wind flow.

The hydrological dynamics in Lokoja are shaped by the merging of two major rivers, which not only modulate moisture levels but also influence surface roughness across the landscape.

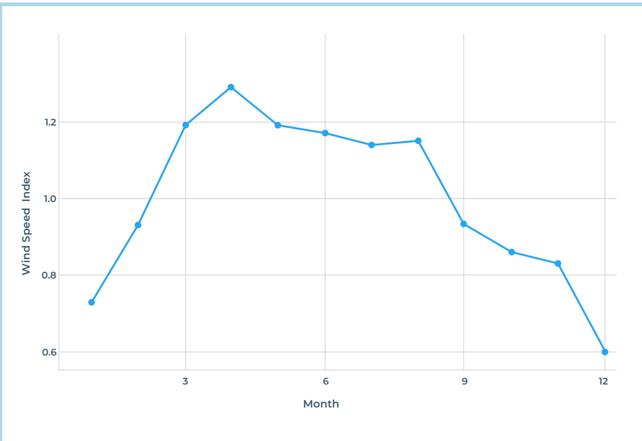


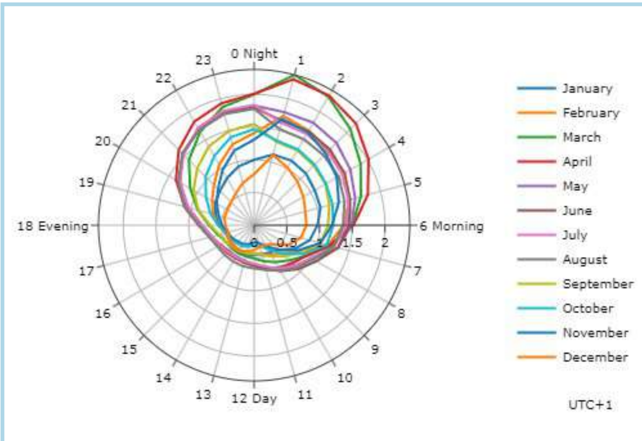






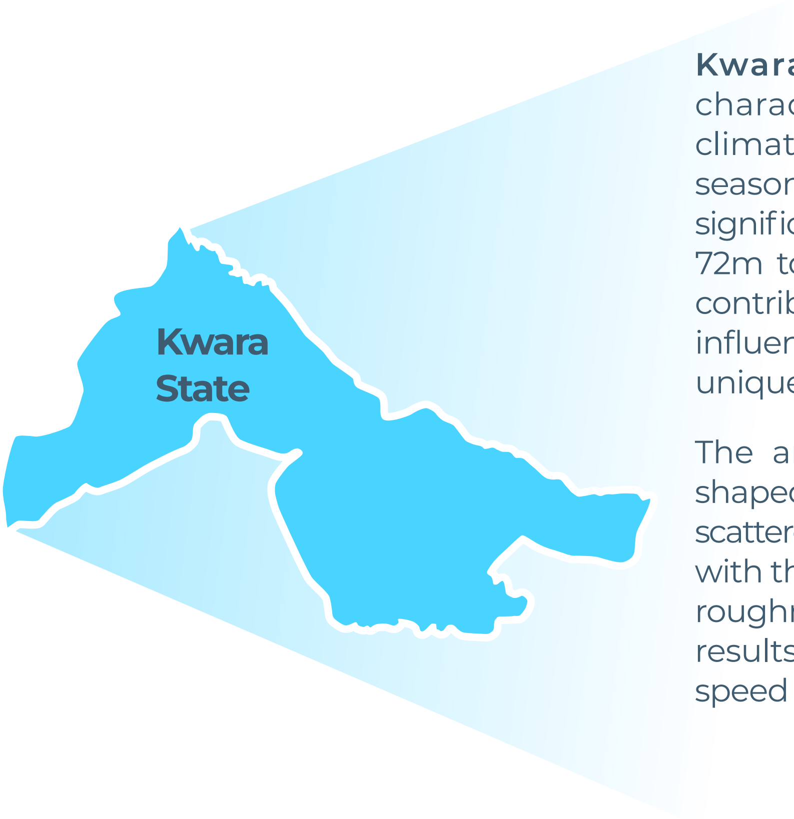
The wind rose diagram for Lokoja indicates the wind blowing predominantly from the Southwest with a little percentage from the South at a mean wind speed of 6.11 m/s and mean power density of 307 W/m² at 10% of the windiest area.





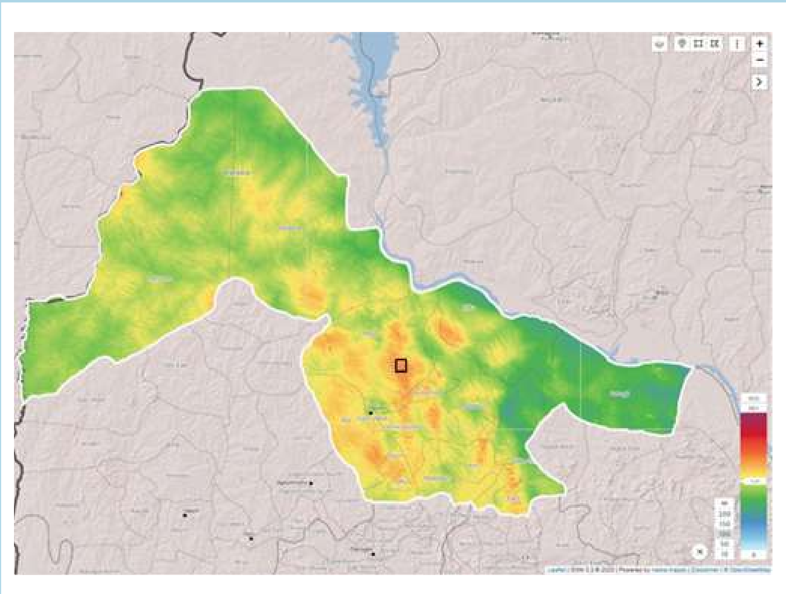
The wind speed in Lokoja peaks in April at 7.88 m/s and is lowest in December at 3.67 m/s. At peak period, we generate up to 4.75MW with the low case generation capacity at 0.48MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

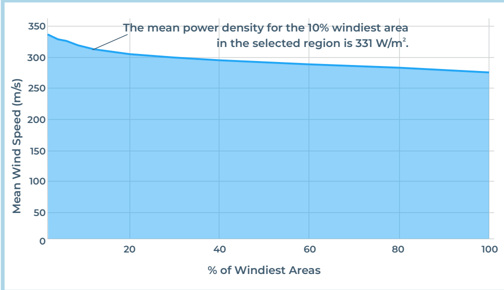
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
8.036114°, 6.651859°	Kogi (North Central)	Lokoja, Kogi State	50m	5.32m/s	228W/m²
			100m	6.11m/s	307W/m²
			150m	6.34m/s	356W/m²

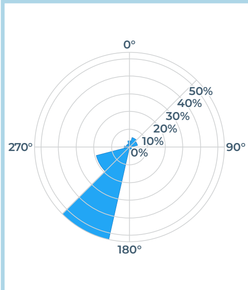


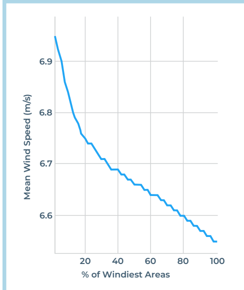
Kwara State - Moro: This area is characterized by a tropical savanna climate, featuring both wet and dry seasons. The region's elevation varies significantly, ranging from approximately 72m to 480m. This variation in altitude contributes to a dynamic landscape that influences local wind patterns, leading to unique micro climatic conditions.

The area's hydrological framework is shaped by seasonal watercourses and scattered vegetation, which, in conjunction with the varied terrain, modulate surface roughness and airflow. This interaction results in subtle fluctuations in wind speed and direction.

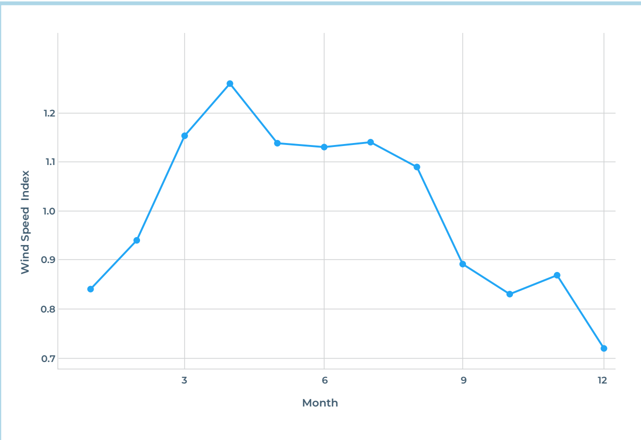


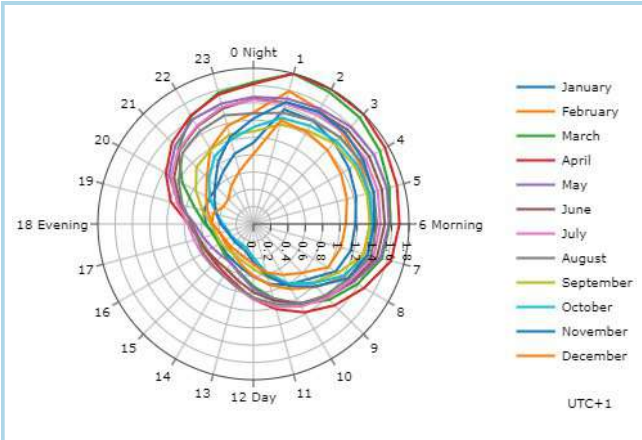






The wind rose diagram for Moro indicates the wind blowing predominantly from the Southwest at a mean wind speed of 6.84 m/s and mean power density of 331 W/m² at 10% of the windiest area.



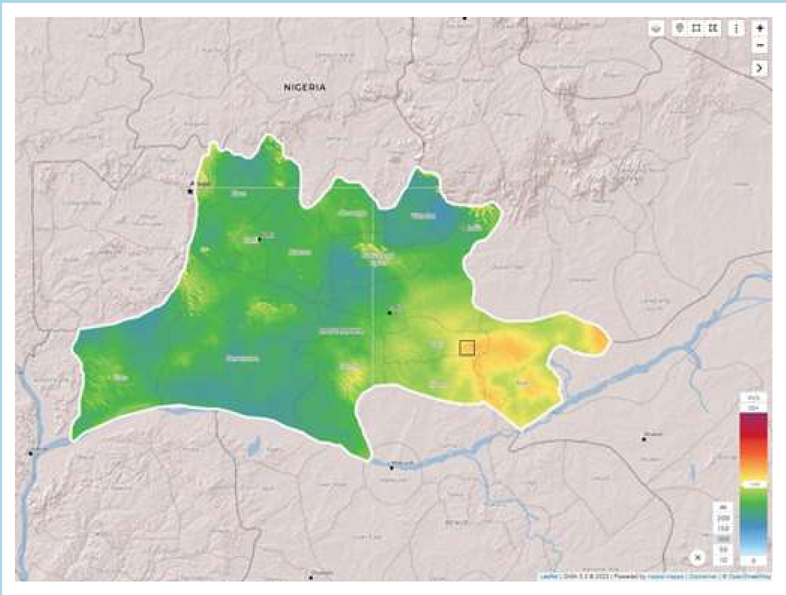


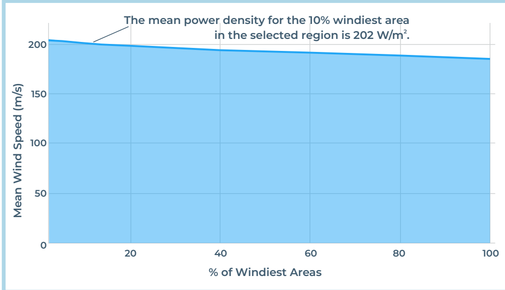
The wind speed in Moro peaks in April at 8.69 m/s and is lowest in December at 4.92m/s. At peak period, we generate up to 6.37MW with the low case generation capacity at 1.16MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

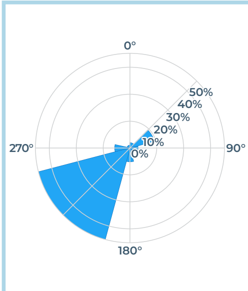
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
8.711359°, 4.695282°	Kwara (North Central)	Moro, Kwara State	50m	5.79m/s	225W/m²
			100m	6.84m/s	331W/m²
			150m	7.77m/s	482W/m²

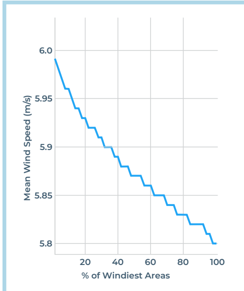
Nasarawa State – Obi: This is located in Nasarawa State, Nigeria, sits at an elevation of 179 meters. The region's gently undulating terrain serves as a natural modulator of wind patterns, where even subtle variations in the landscape create localized micro climatic effects.

The hydrological framework in Obi is influenced by seasonal watercourses and native vegetation, which work together to alter surface roughness and regulate airflow. This synergy between the natural environment and the terrain plays a crucial role in shaping the area's wind dynamics, leading to nuanced variations in wind speed and direction.

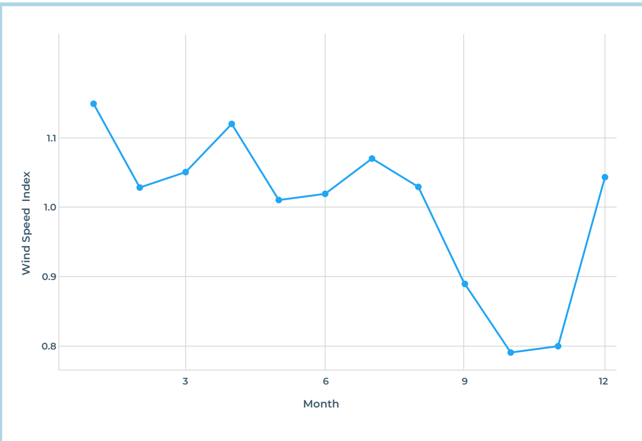


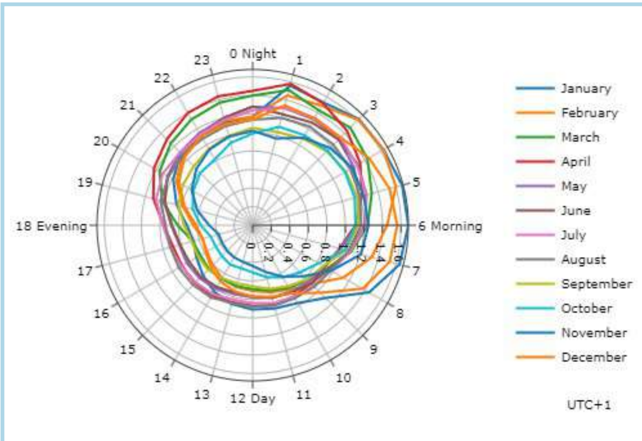






The wind rose diagram for Obi indicates the wind blowing predominantly from the Southwest at a mean wind speed of 5.96 m/s and mean power density of 202 W/m² at 10% of the windiest area.



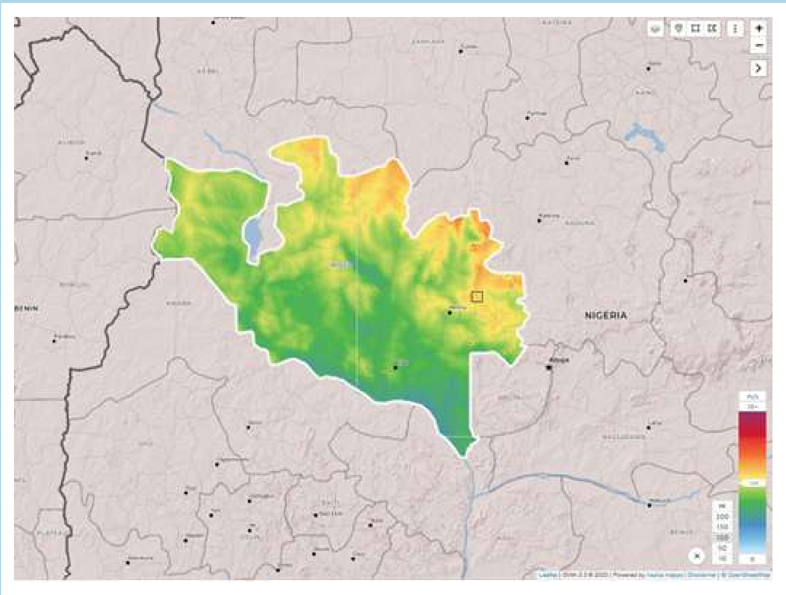


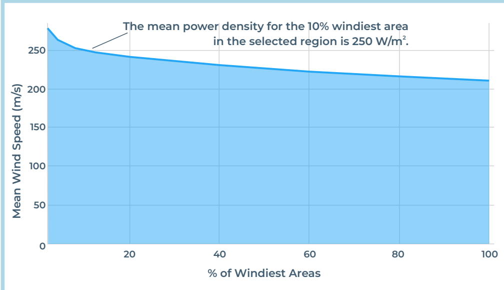
The wind speed in Obi peaks in January at 7.03 m/s and is lowest in October at 4.71m/s. At peak period, we generate up to 3.37MW with the low case generation capacity at 1.01MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

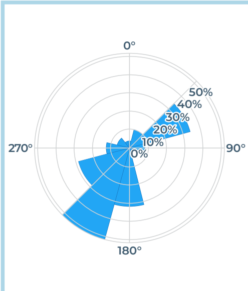
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
8.324817°, 8.91807°	Nasarawa (North Central)	Obi, Nasarawa State	50m	5.04m/s	141W/m²
			100m	5.96m/s	202W/m²
			150m	6.7m/s	289W/m²

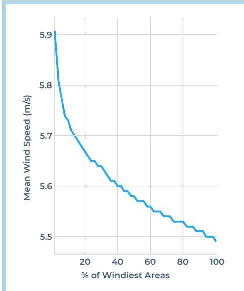
Niger State – Shiroro: This area is distinguished by the presence of the Shiroro Dam on the Kaduna River and sits at an elevation of 498m. The engineered and natural landscape creates a unique environment where the dam's reservoir and the surrounding terrain work together to shape local wind patterns.

The hydrological dynamics of the area are characterized by a low base flow and marked seasonal fluctuations of the Kaduna River. These variations in water levels, in conjunction with the topography, influence moisture distribution and surface roughness, thereby modulating wind speeds and directions across the region.

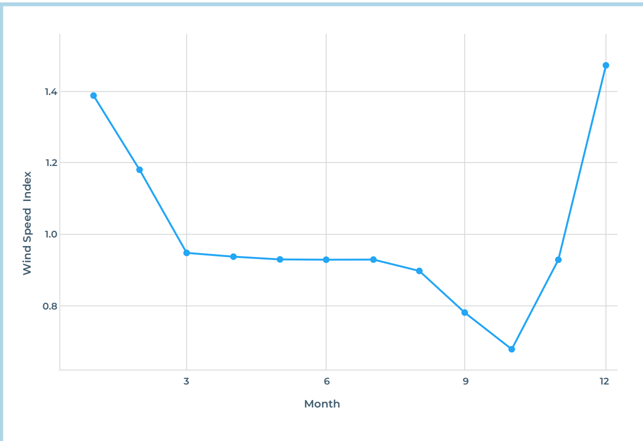


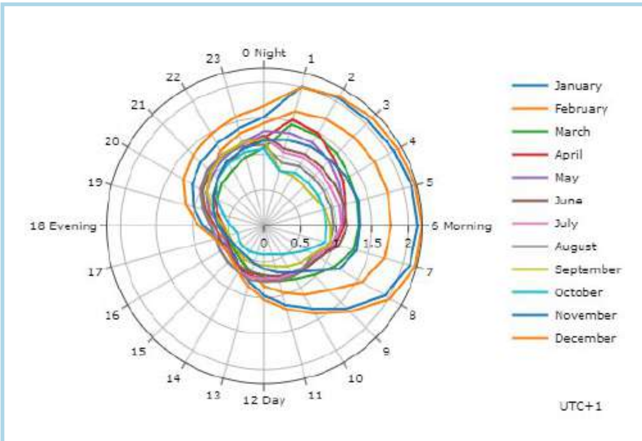






The wind rose diagram for Shiroro indicates the wind blowing predominantly from the Southwest and Northeast directions at a mean wind speed of 5.73 m/s and mean power density of 250 W/m² at 10% of the windiest area.



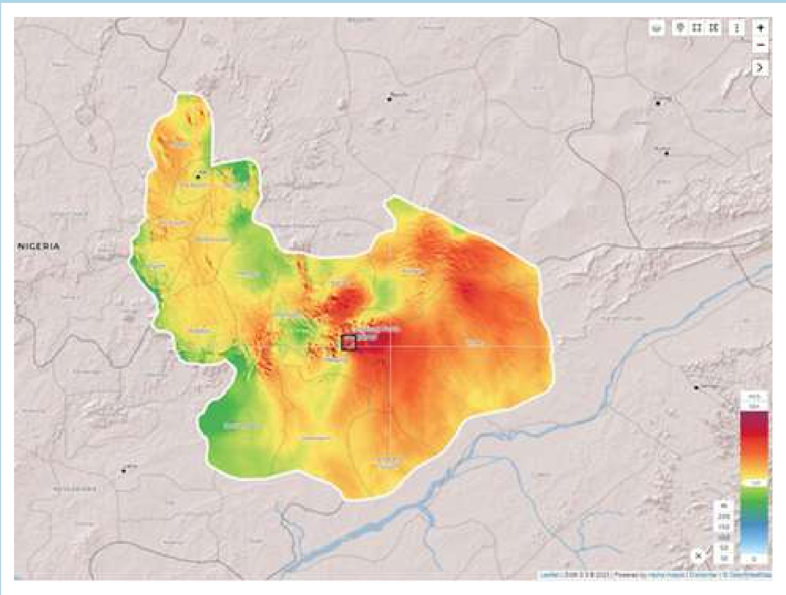


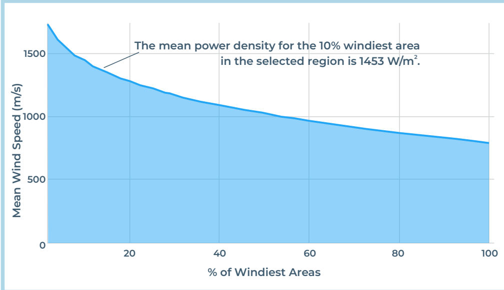
Shiroro's wind speed peaks in December at 8.42 m/s and is lowest in October at 4.33m/s. At peak period, we generate up to 3.90MW with the low case generation capacity at 0.57MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

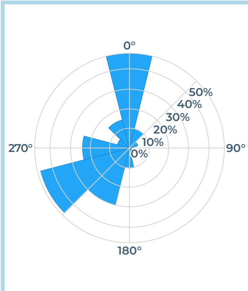
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
9.583824°, 6.547165°	Niger (North Central)	Shiroro, Niger State	50m	4.88m/s	176W/m²
			100m	5.73m/s	250W/m²
			150m	6.44m/s	369W/m²

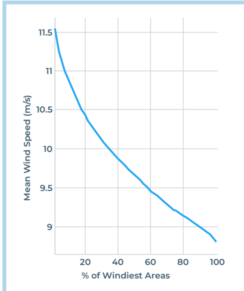
Plateau State – Pankshin: This location spans 1,524km² and has an estimated population of approximately 279,700 people as of 2022. The region features an elevated landscape, with elevations reaching up to 1,225m above sea level.

Pankshin's climate is classified as tropical savanna (Köppen climate classification: Aw), characterized by warm temperatures year-round. The wet season is muggy and overcast, while the dry season is partially cloudy. Throughout the year, temperatures typically range from 12°C to 32°C, rarely falling below 9°C or rising above 35°C.

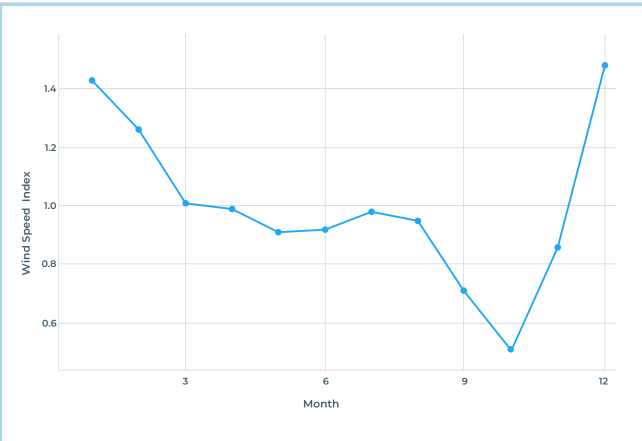


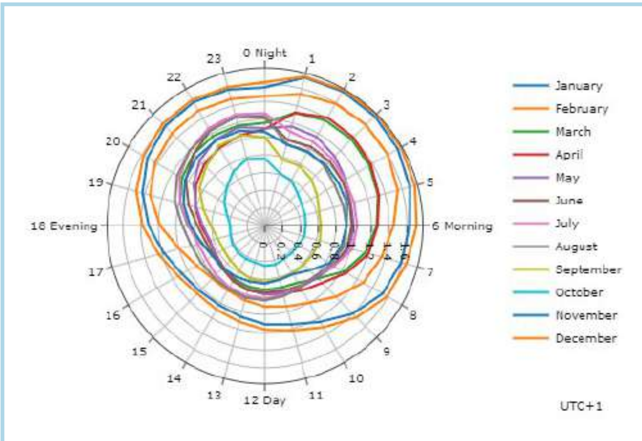






The wind rose diagram for Pankshin indicates the wind blowing predominantly from the North and Southwest directions at a mean wind speed of 10.90 m/s and mean power density of 1453 W/m² at 10% of the windiest area. This is about the highest wind speeds in the areas considered in this study.



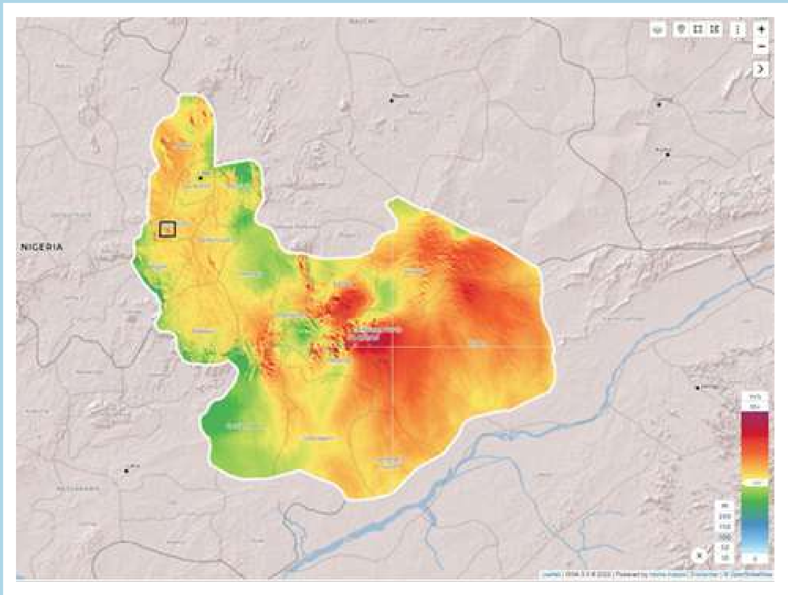


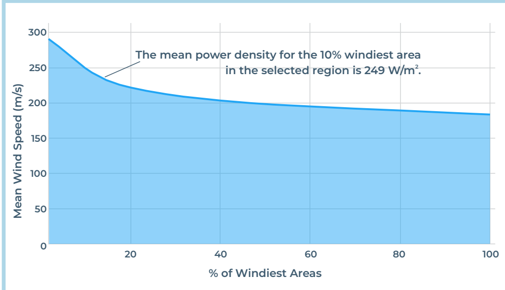
Pankshin's wind speed peaks in December at 8.37 m/s and is lowest in September at 4.92m/s. At peak period, we generate up to 5.69MW with the low case generation capacity at 1.16MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

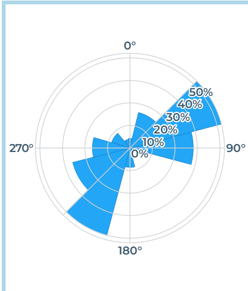
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
9.14413°, 9.673116°	Plateau (North Central)	Pankshin, Plateau State	50m	10.28m/s	1349W/m²
			100m	10.9m/s	1453W/m²
			150m	10.74m/s	1322W/m²

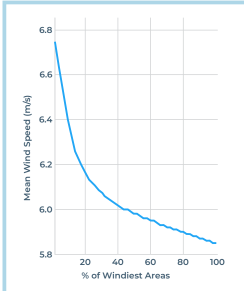
Plateau State – Jos South: This location spans 510km^2 with an estimated population of 458,100. Located in north-central Nigeria, its headquarters is in Bukuru. Notable landmarks include the Plateau State Government House in Rayfield, the National Institute for Policy and Strategic Studies (NIPSS) in Kuru, and the 330 Nigerian Air Force Station.

The region's varied topography ranges from 1,105m to 1,514m above sea level, averaging 1,243m. This elevation contributes to its unique climate and scenic landscapes. The average temperature is 28°C, with two main seasons: the dry season and the rainy season, receiving 1,750 mm of annual precipitation.

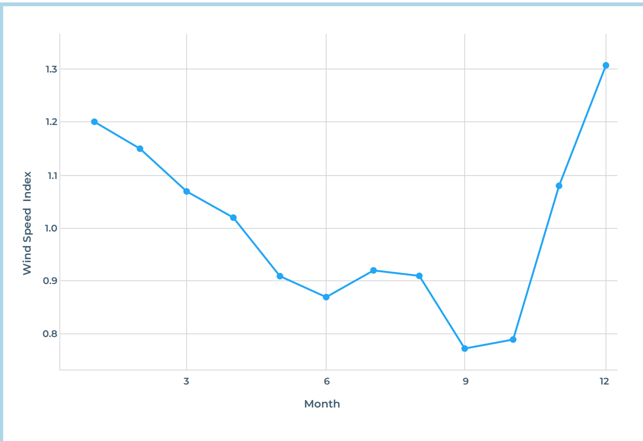


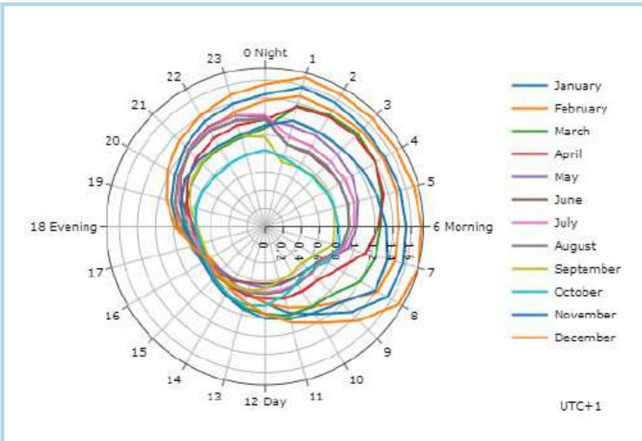






The wind rose diagram for Jos South indicates the wind blowing predominantly from the Southwest and Northwest directions at a mean wind speed of 6.39 m/s and mean power density of 249 W/m² at 10% of the windiest area.





Jos South's wind speed peaks in December at 8.37 m/s and is lowest in September at 4.92m/s. At peak period, we generate up to 5.69MW with the low case generation capacity at 1.16MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
9.69586°, 8.73447°	Plateau (North Central)	Jos South, Plateau State	50m	5.54m/s	191W/m²
			100m	6.39m/s	249W/m²
			150m	6.85m/s	3142W/m²

North-East Region

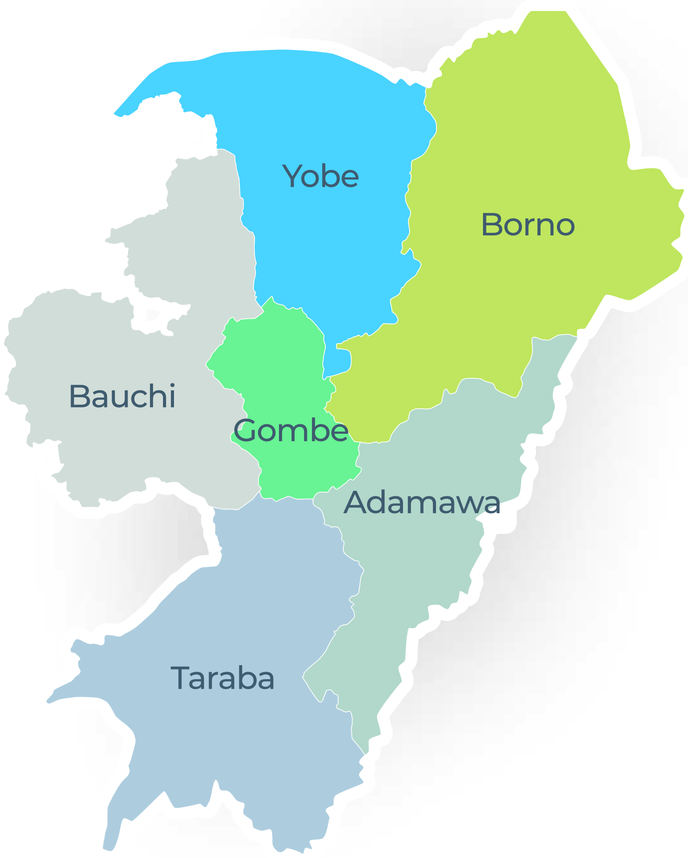
North-East Region

States: Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe

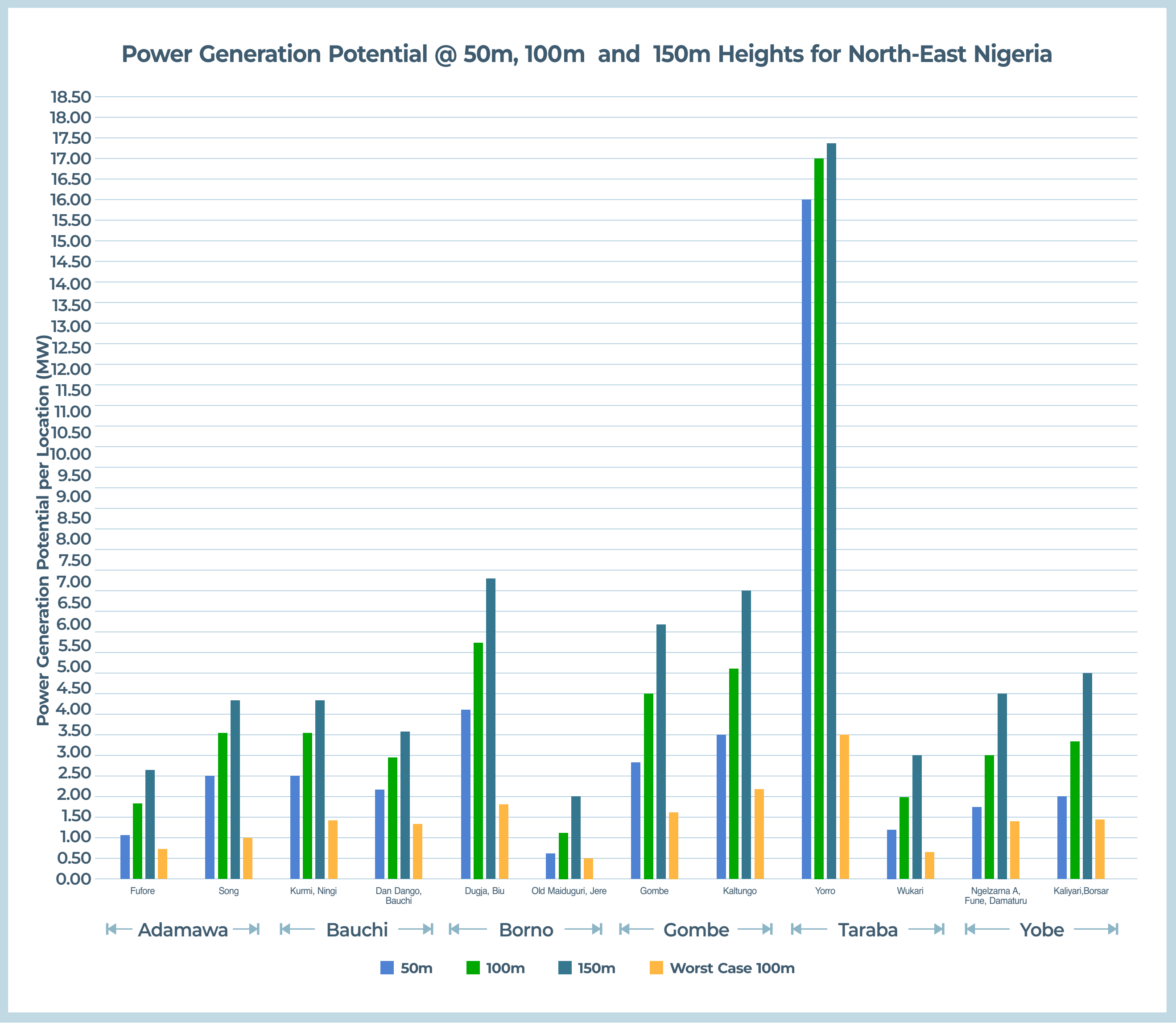
Summary: Nigeria's Northeast region comprises of 6 states. The region is home to about 26 million people and its major cities are Maiduguri, Yola, Bauchi and Gombe. Energy penetration in the region is estimated at a paltry 20.9% with about 79% of the populace with no access to electricity. This region presents a huge gap in electricity penetration and an intervention here will go a long way to boost economic activities in its rural and urban areas.

Unfortunately, the area has been inundated with security challenges that has damaged power infrastructure and this may not be unconnected to the very low power penetration. 12 locations across the 6 states have been evaluated with Yorro in the Taraba high lands having the best wind speeds at 12.07 m/s at 100m heights.

However, the terrain may be difficult to access because of its remoteness and mountainous nature. Gombe presents super potential as the wind speed is as high as 7.7 m/s at accessible locations with sufficient land in the city. Bauchi also presents a fantastic candidate as the wind speeds reach up to 6.7 m/s at 100 m heights.

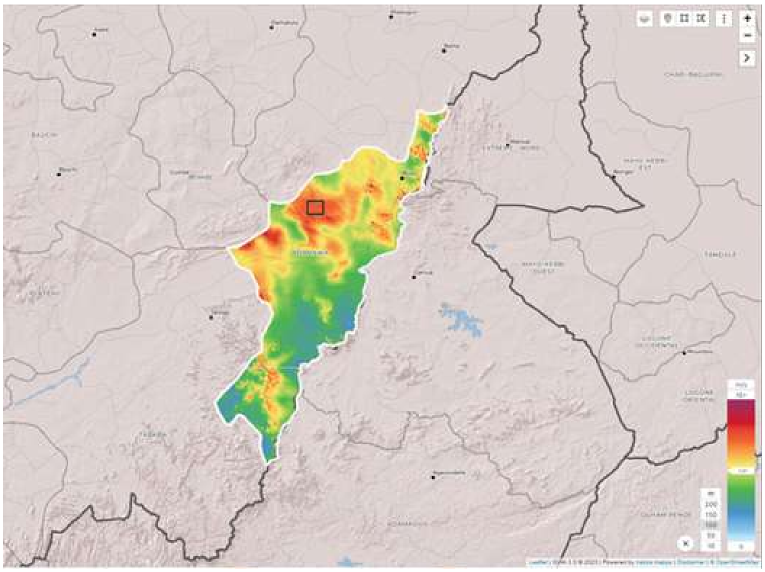


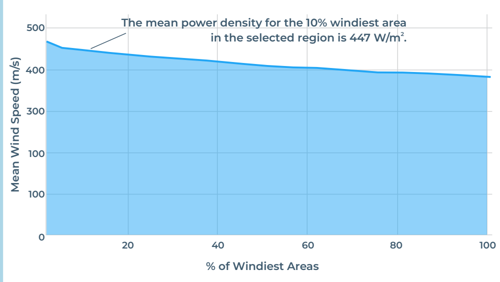
Wind Power Potential											
			50m		100m		150m		Worst Case Scenario		
State	Location	Coordinates	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Wind Speed (m/s)	Power (MW)	Month
Adamawa	Fufore	9.305777°, 12.589901°	4.76	1.05	5.68	1.78	6.46	2.61	4.20	0.72	October
	Song	9.975463°, 12.392487°	6.37	2.51	7.54	4.16	7.62	4.29	4.90	1.14	October
Bauchi	Kurmi, Ningi	11.019385°, 9.173073°	6.43	2.58	7.16	3.56	7.66	4.36	5.23	1.39	October
	Dan Dango, Bauchi	10.211806°, 12.131653°	6.09	2.19	6.7	2.92	7.17	3.58	5.16	1.33	October
Borno	Dugja, Biu	10.644412°, 12.131653°	7.49	4.08	8.39	5.73	9.10	7.31	5.71	1.80	October
	Old Maiduguri, Jere	11.859287°, 13.183594°	3.97	0.61	4.86	1.11	5.93	2.02	3.69	0.49	October
Gombe	Gombe	10.289473°, 11.134393°	6.57	2.75	7.72	4.46	8.59	6.15	5.48	1.60	October
	Kaltungo	9.803948°, 11.564166°	7.09	3.46	8.08	5.12	8.97	7.00	6.06	2.16	October, November
Taraba	Yorro	8.850132°, 11.612206°	11.82	16.02	12.07	17.06	12.15	17.40	7.12	3.50	November
	Wukari	7.743651°, 9.809418°	4.94	1.17	5.89	1.98	6.79	3.04	4.06	0.65	November
Yobe	Ngelzarna A, Fune, Damaturu	11.761159°, 11.832275°	5.59	1.69	6.7	2.92	7.77	4.55	5.23	1.38	October
	Kaliyari, Borsar	12.88678°, 11.524658°	5.86	1.95	6.94	3.24	8.05	5.06	5.27	1.42	Septmeber

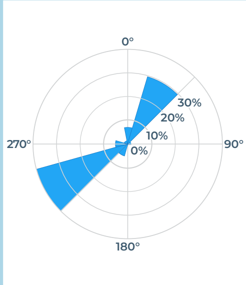


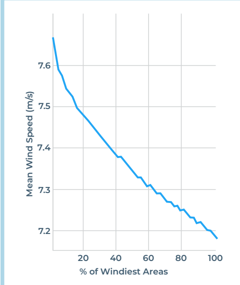
Adamawa State – Song: This location features diverse topography ranges at an elevation of approximately 307m. Seasonal rivers and streams shape local wind patterns and moisture distribution, influencing its hydrology. The surface roughness, dominated by Sudan savanna vegetation with grasslands and sporadic woodlands, regulates airflow. The town's economy, based on trade and agriculture, balances traditional rural settlements with new urban centers.

This synthesis of natural landforms, hydrological influences, and evolving development underscores Song's potential.

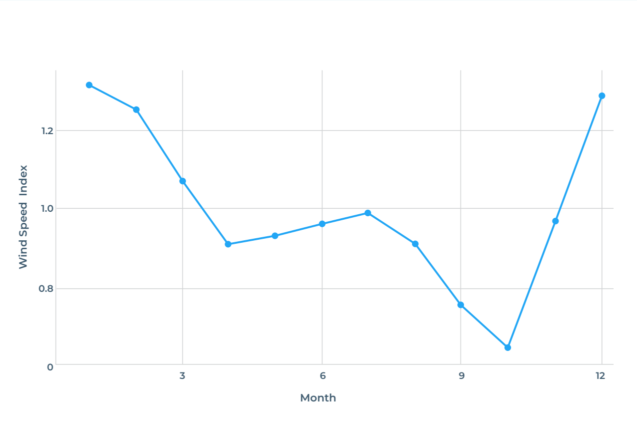


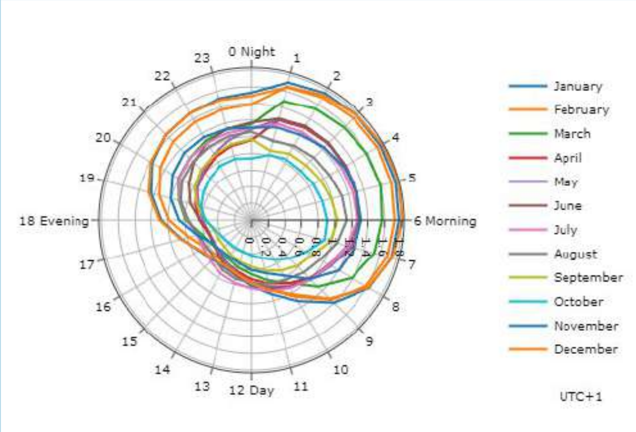






The wind rose diagram of our location in Song indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 7.54 m/s and mean power density of 447 W/m² at 10% of the windiest area.



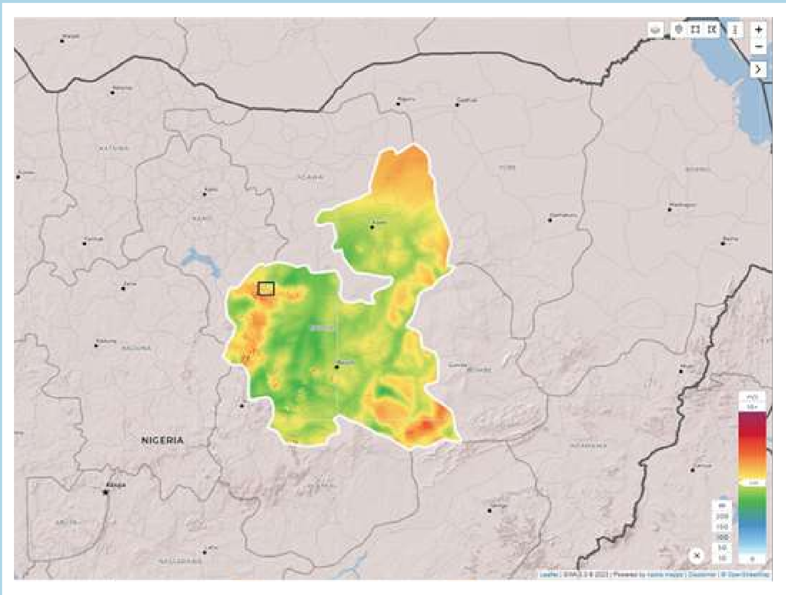


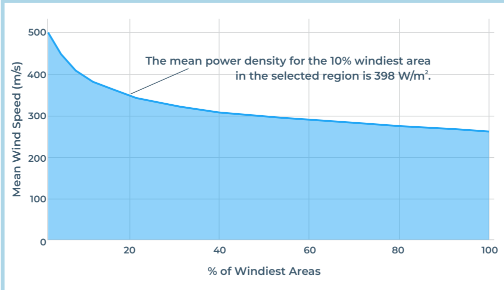
Song's wind 35% speed peaks in January at 9.88 m/s and is lowest in October at 4.90 m/s. At peak period, we generate up to 9.35MW with the low case generation capacity at 1.14MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

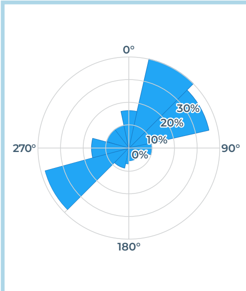
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
9.975463°, 12.392487°	Adamawa (North East)	Song	50m	6.43m/s	312W/m²
			100m	7.54m/s	447W/m²
			150m	8.43m/s	602W/m²

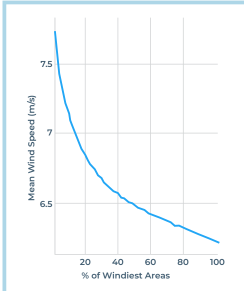
Bauchi State – Kurmi, Ningi: This is a rural community rooted in traditional agriculture. The terrain is characterized by rounded hills, with elevations reaching nearly 2,850ft and local peaks between 854m and 1,167m. Dynamic wind patterns are shaped by these features throughout the plateau.

Seasonal rainfall creates intermittent streams, and sparse vegetation influences surface roughness. Improved rural roads and emerging infrastructure suggest a gradual urbanization process.

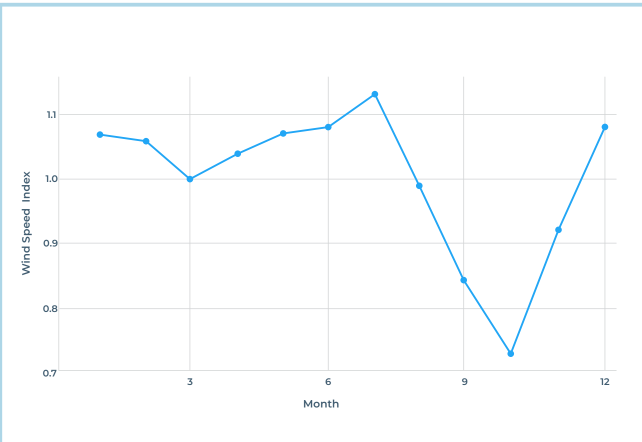


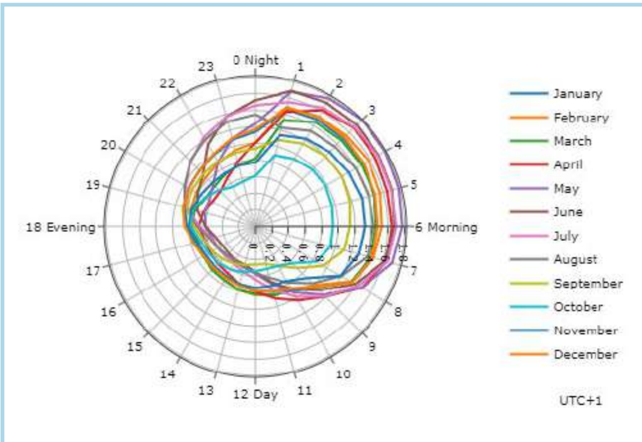






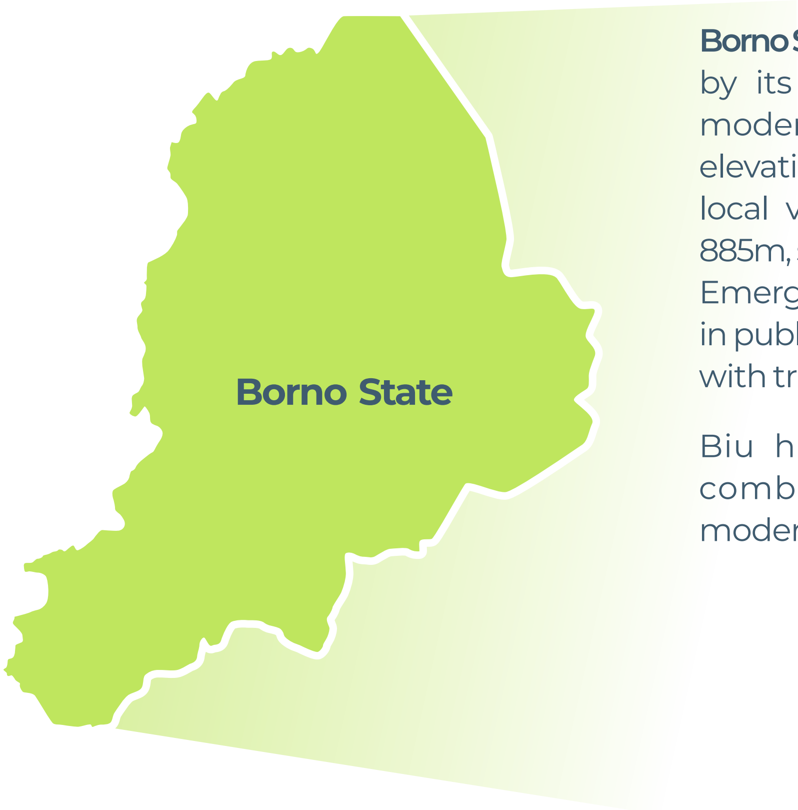
The wind rose diagram of our location in Kurmi, Ningi indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 7.16 m/s and mean power density of 398 W/m² at 10% of the windiest area.





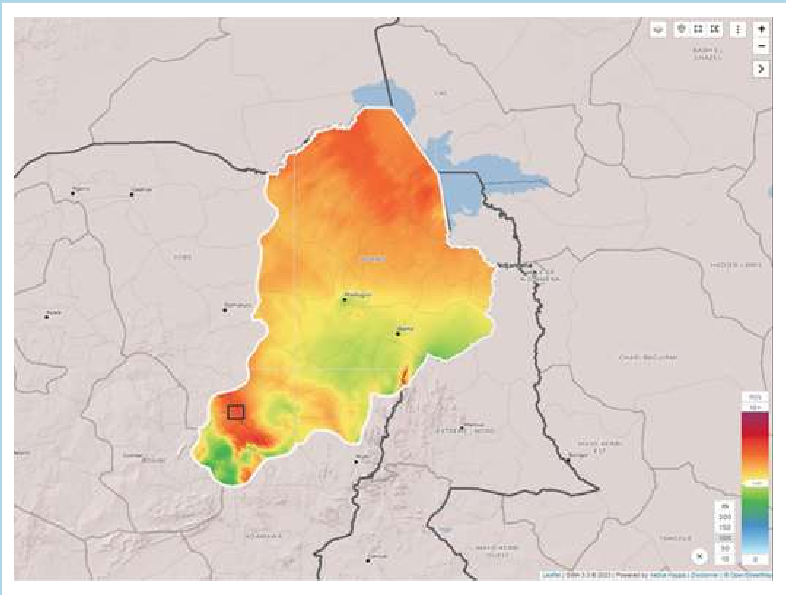
The wind speed in Ningi is highest in July at 8.10m/s and lowest in October at 5.23 m/s. At peak period, we generate up to 5.15MW with the low case generation capacity at 1.39MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

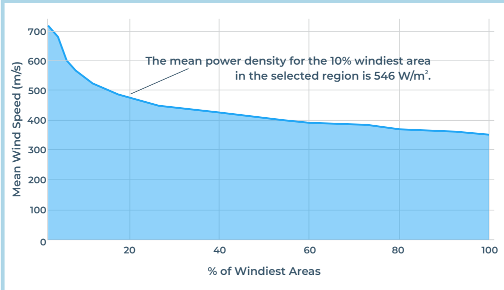
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
11.019385°, 9.173073°	Bauchi (North East)	Kurmi, Ningi, Bauchi State	50m	6.43m/s	343W/m²
			100m	7.16m/s	398W/m²
			150m	7.66m/s	500W/m²

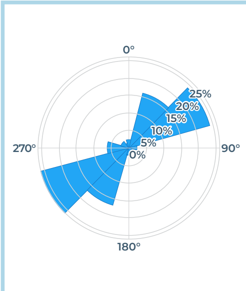


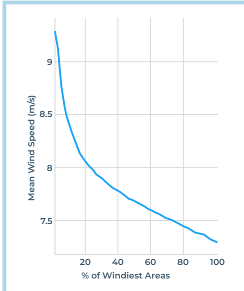
Borno State - Biu: This area is characterized by its semi-arid climate and gradual modernization. The plateau's average elevation of approximately 626m, with local variations ranging from 399m to 885m, significantly shapes wind dynamics. Emerging infrastructure advancements in public spaces and marketplaces coexist with traditional lifestyles.

Biu has an interesting and unique combination of rural heritage and modern development.

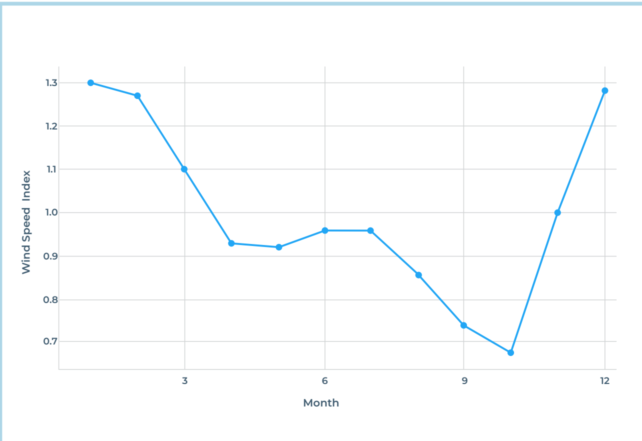


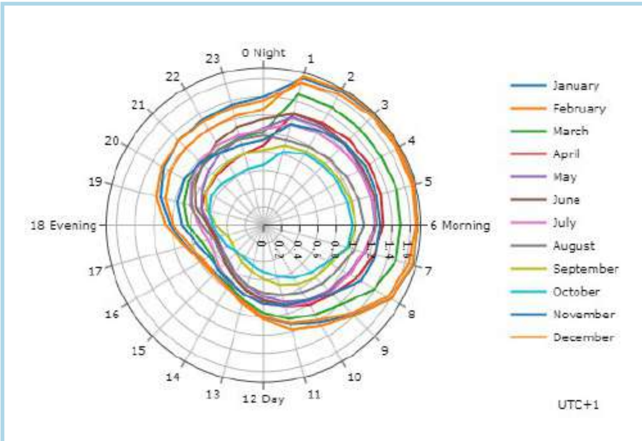






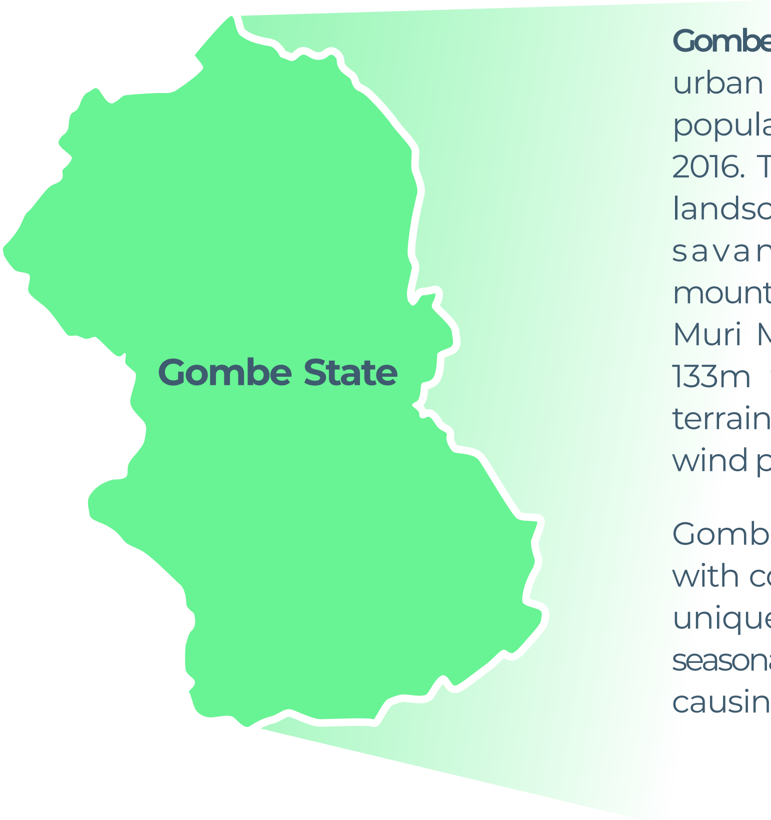
The wind rose diagram of our location in Biu indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 8.44 m/s and mean power density of 546 W/m² at 10% of the windiest area.





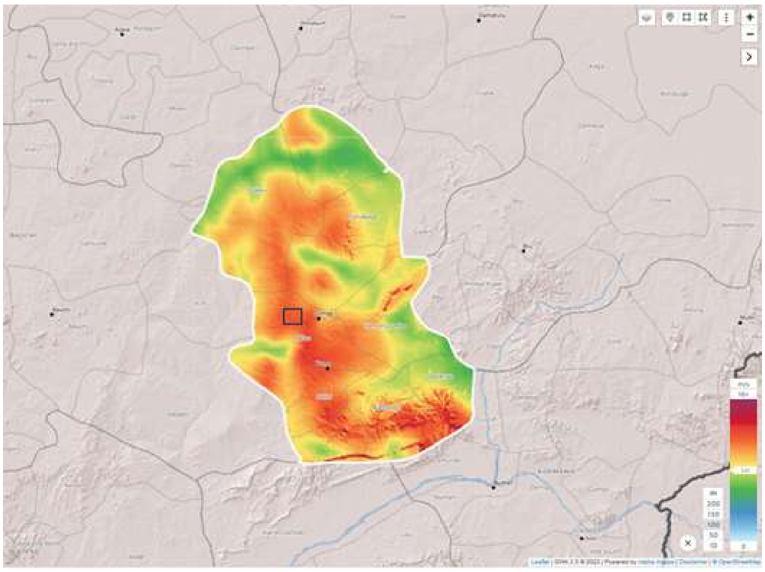
The wind speed in Biu is highest in January at 8.44m/s and is lowest in October at 5.74 m/s. At peak period, we generate up to 12.18MW with the low case generation capacity at 1.83MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

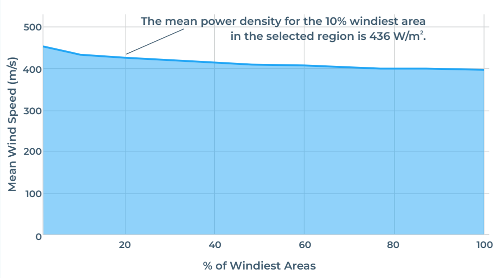
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
10.644412°, 12.131653°	Borno (North East)	Dugja, Biu, Borno State	50m	7.49m/s	447W/m²
			100m	8.44m/s	546W/m²
			150m	9.10m/s	687W/m²

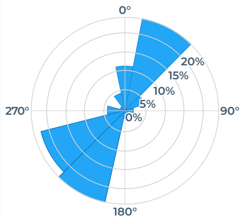


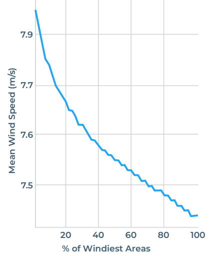
Gombe State-Gombe: This is an important urban center and regional hub with a population of roughly 3.25 million as of 2016. The city is surrounded by a varied landscape, including rolling hills, vast savannah vegetation, and rocky mountains in the southeast, such as the Muri Mountains. Elevations range from 133m to 1,023m, resulting in intricate terrain interactions that affect regional wind patterns.

Gombe combines traditional customs with contemporary urbanization, and its unique microclimate is influenced by seasonal watercourses and native vegetation, causing subtle changes in wind speed.

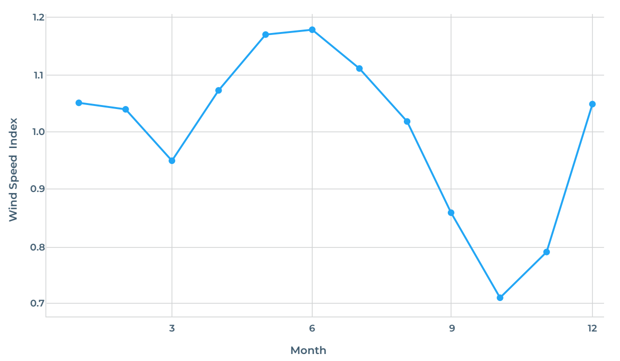


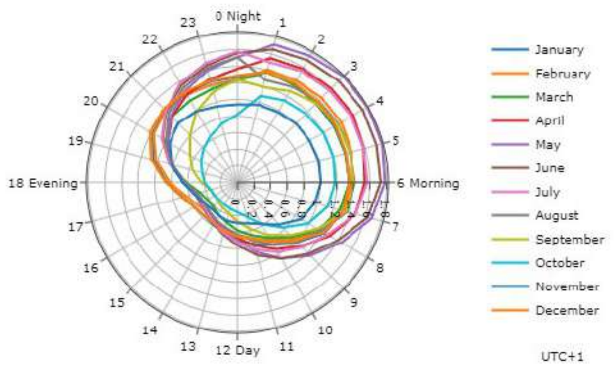






The wind rose diagram of our location in Gombe indicates the wind blowing predominantly from the Northeast and Southwest directions at a mean wind speed of 7.72 m/s and mean power density of 436 W/m² at 10% of the windiest area.



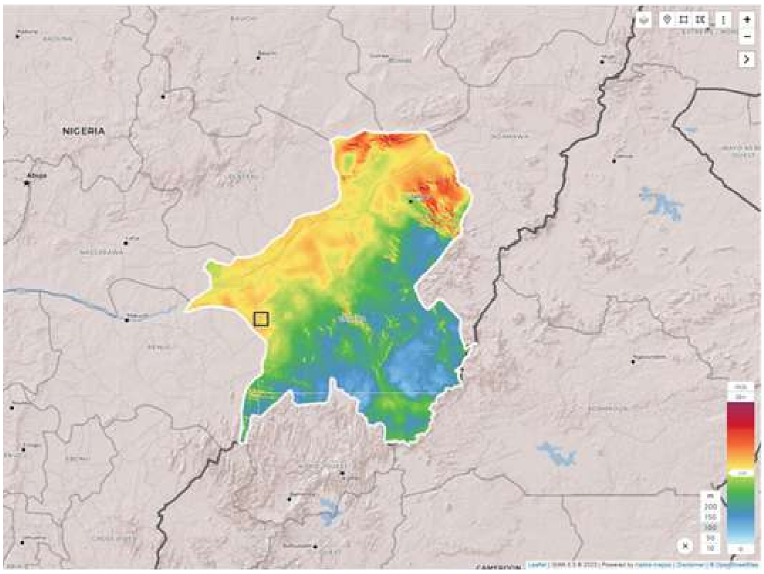


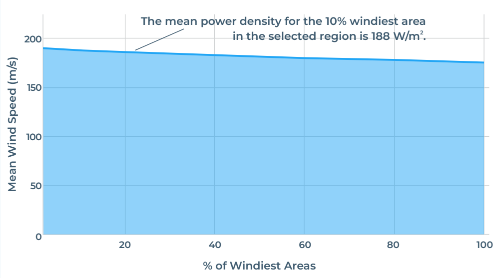
The wind speed in Gombe is highest in June at 9.11m/s and is lowest in October at 5.48 m/s. At peak period, we generate up to 7.33MW with the low case generation capacity at 1.60MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

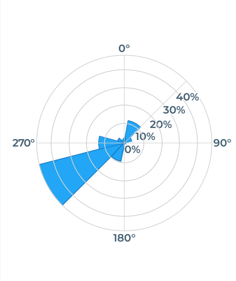
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
10.293639°, 11.133868°	Gombe (North East)	Gombe, Gombe State	50m	6.59m/s	308W/m²
			100m	7.74m/s	436W/m²
			150m	8.61m/s	604W/m²

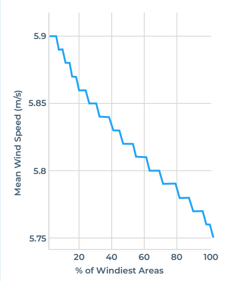
Taraba State – Wukari: This area spans about 4,308 km² and is home to around 374,800 people, primarily the Jukun. The region's varied topography ranges from 73m to 787m above sea level, with an average elevation of 145m. The Benue and Donga Rivers flow through the area, making it fertile and ideal for agriculture.

The climate is humid tropical, with distinct wet (April to October) and dry seasons. Peak rainfall occurs between June and August, averaging 1,500 mm annually. Temperatures typically range from 25°C to 35°C.

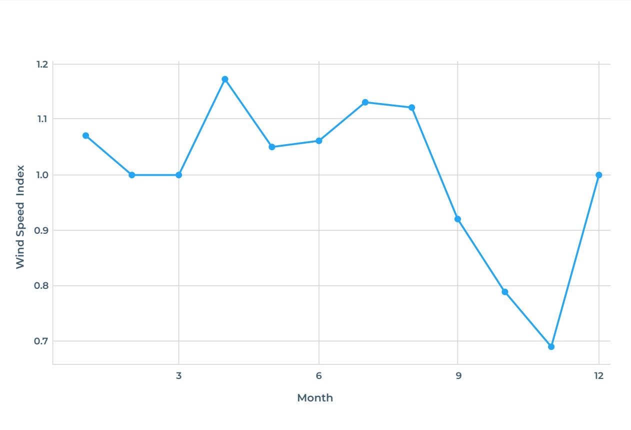


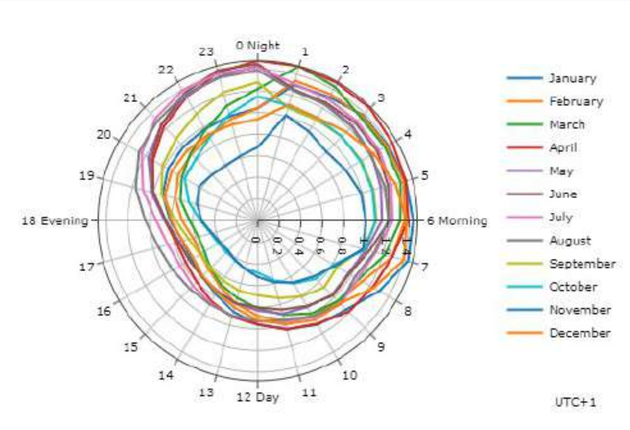






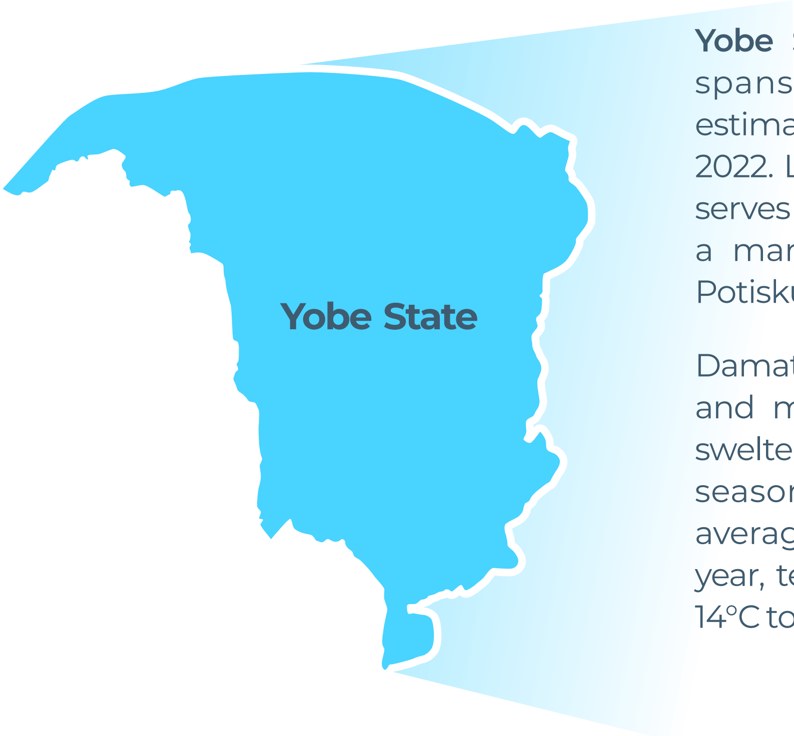
The wind rose diagram for Wukari indicates the wind blowing predominantly from the Southwest direction at a mean wind speed of 5.89 m/s and mean power density of 188 W/m² at 10% of the windiest area.





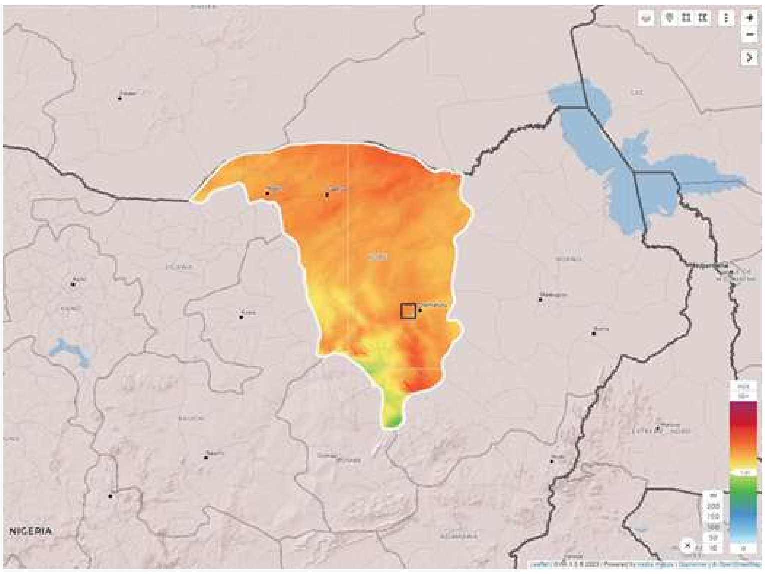
The wind speed in Wukari is highest in April at 6.95m/s and is lowest in October at 4.06 m/s. At peak period, we generate up to 3.26MW with the low case generation capacity at 0.65MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

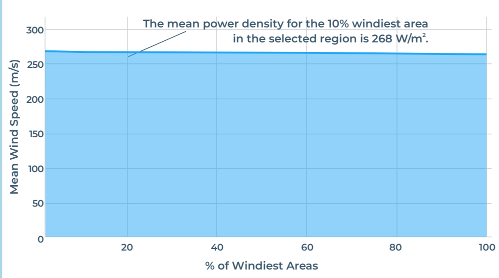
Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
7.743651°, 9.809418°	Taraba (North East)	Wukari, Taraba State	50m	4.94m/s	126W/m²
			100m	5.89m/s	188W/m²
			150m	6.79m/s	301W/m²

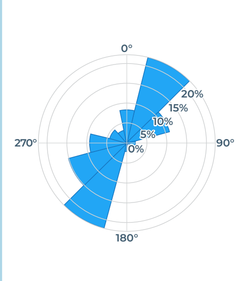


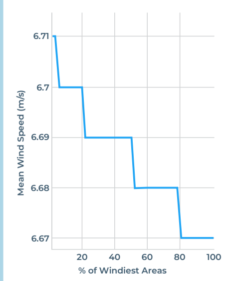
Yobe State – Damaturu: This location spans about 2,366km² and has an estimated population of 137,900 as of 2022. Located in northeastern Nigeria, it serves as the capital of Yobe State and is a market hub on the road between Potiskum and Maiduguri.

Damaturu experiences a hot, oppressive, and mostly cloudy wet season, and a sweltering, windy, and partly cloudy dry season. August sees the most rain, averaging 170.18mm. Throughout the year, temperatures typically range from 14°C to 40°C.

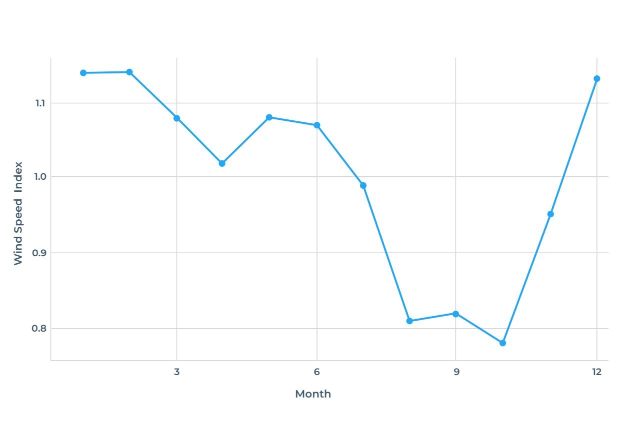


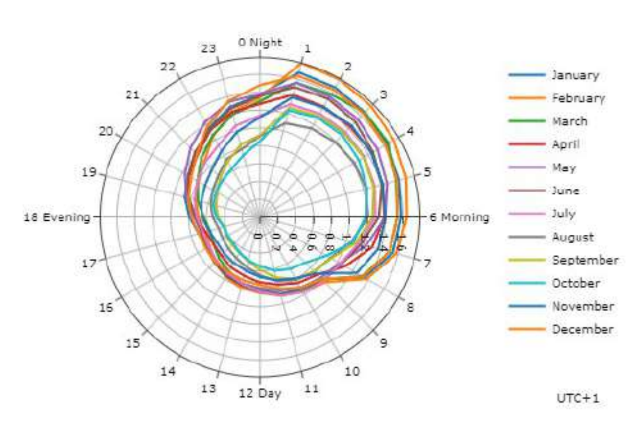






The wind rose diagram for Damaturu indicates the wind blowing predominantly from the Southwest and Northeast directions at a mean wind speed of 6.70 m/s and mean power density of 268 W/m² at 10% of the windiest area.





The wind speed in Damaturu is highest in February and December at 7.77 m/s and is lowest in November at 5.23 m/s. At peak period, we generate up to 4.55MW with the low case generation capacity at 1.38MW, assuming we have 150m turbine blade diameter, air density of 1.225 kg/m³, and a capacity factor of 35%.

Coordinates	State (Region)	Location	Height	Wind Speed	Power Gen
11.761159°, 11.832275°	Yobe (North East)	Ngelzarma A, Fune, Damaturu Yobe State	50m	5.59m/s	179W/m²
			100m	6.7m/s	268W/m²
			150m	7.77m/s	440W/m²

Donga River, Tonga Yasin, Taraba State

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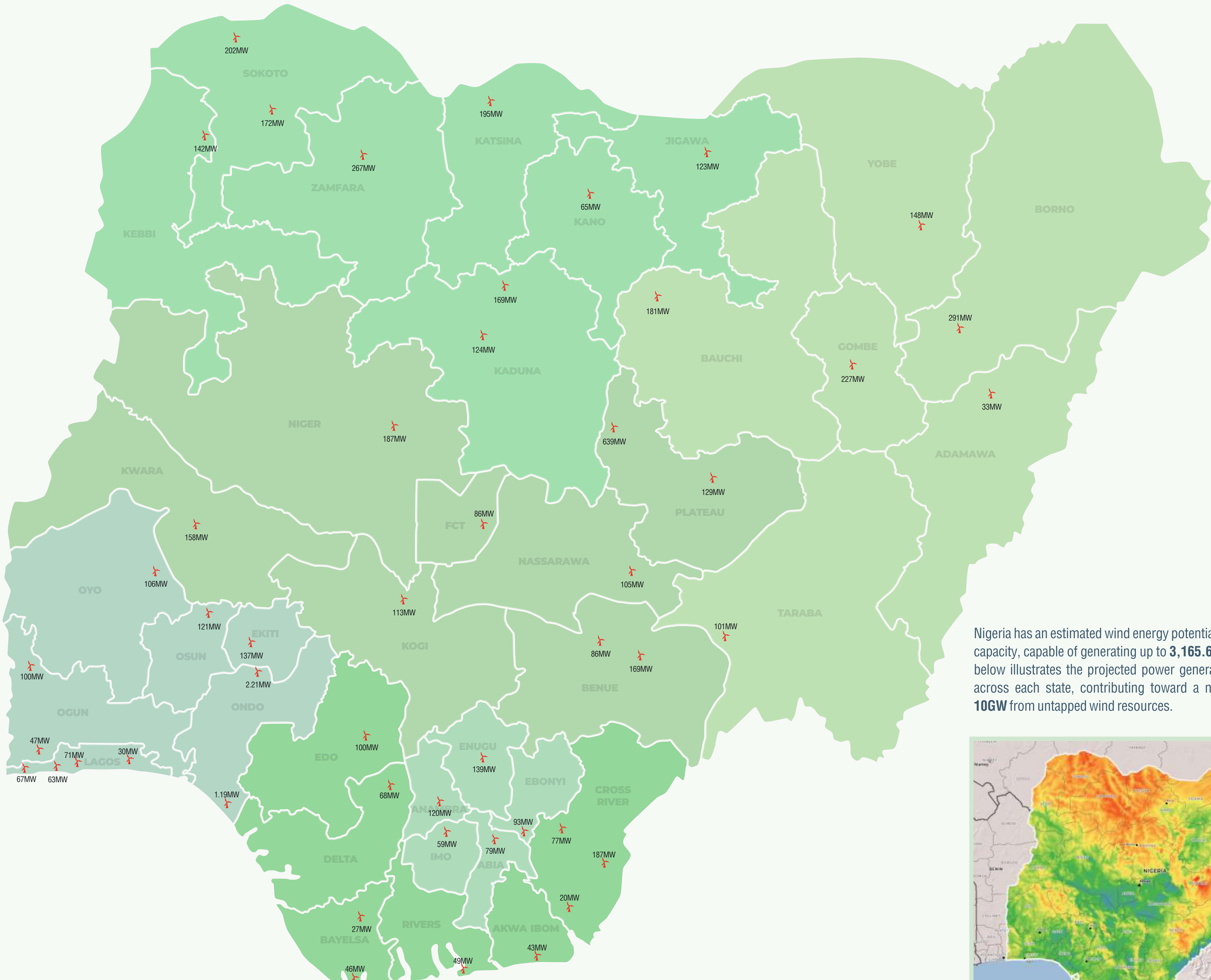
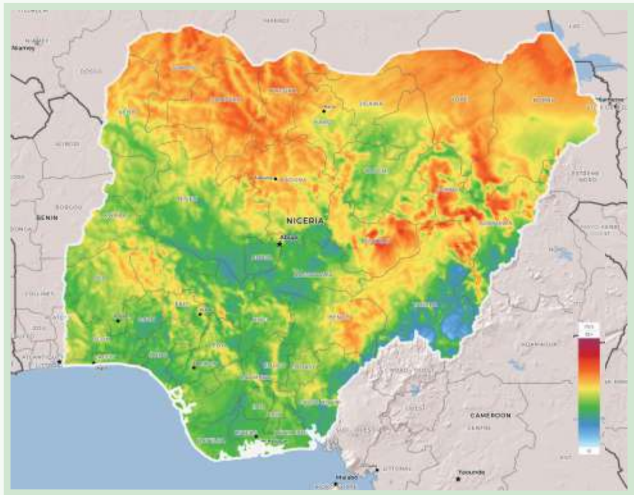
This is based on the following assumptions: Height - 100m | Air Density - 1.225kg/m³ | Capacity Factor - 35% | Turbine Blade Diameter - 150m



Nigeria has an estimated wind energy potential of **1,261.1GW** in installed capacity, capable of generating up to **3,165.6TWh annually****. The map below illustrates the projected power generation from select locations across each state, contributing toward a national goal of generating **10GW** from untapped wind resources.



Region/State/Location	Wind Turbine Capacity (MW)	No. of Wind Turbines	Potential Power Generation (MW)
SOUTH-WEST			
Ekiti			
Ado Ekiti	5	28	137
Lagos			
Ibeshe	3	23	67
Alaro City	1.5	21	30
Ilashe Beach	3	24	71
Badagry	2	32	63
Ogun			
Guandong Free Trade Zone	2	24	47
Abeokuta North	4	25	100
Ondo			
Ilaje	2	28	55
Akure North	4	30	117
Osun			
Otan Ayegbaju, Boluwaduro	4	31	121
Oyo			
Ori-Ire	4	27	106
SOUTH-SOUTH			
Akwa Ibom			
Ibeno	2	22	43
Bayelsa			
Yenegoa	1.5	19	27
Brass	2	23	46
Cross River			
Akamkpa	6	32	187
Yakurr	3	26	77
Calabar	1.5	14	20
Delta			
Aniocha South	3	23	68
Edo			
Uromi, Esan North-East	4	26	100
Rivers			
Bonny	2	25	49
SOUTH-EAST			
Abia			
Bende	3	27	79
Anambra			
Aguata	4	30	120
Ebonyi			
Afikpo South	3	32	93
Enugu			
Udi	5	28	139
Imo			
Nkwerre	2	30	59
NORTH-WEST			
Jigawa			
Dabuwaran, Kaugama	4	31	123
Kaduna			
Rigachikun, Igabi	4	32	124
Kufena, Zaria	6	29	169
Kano			
Northern Nigeria Flour Mills	3	22	65
Katsina			
Jino, Batagarawai	7	28	195
Kebbi			
Maruda, Gwandu	5	29	142
Sokoto			
Fajaldu, Dange-Shuni	6	29	172
Magonho, Tangaza	7	29	202
Zamfara			
Kanoma, Maru	9	30	267
NORTH-CENTRAL			
Benue			
Makurdi	3	29	86
Gboko	6	29	169
FCT, Abuja			
Bwari	3	29	86
Kogi			
Lokoja	4	29	113
Kwara			
Moro	4	32	158
Nasarawa			
Obi	4	27	105
Niger			
Shiroro	6	32	187
Plateau			
Pankshin	15	43	639
Jos South	4	33	129
NORTH-EAST			
Adamawa			
Song	2	17	33
Bauchi			
Kurmi, Ningi	6	31	181
Borno			
Dugja, Biu	10	30	291
Gombe			
Gombe	8	29	227
Taraba			
Wukari	4	26	101
Yobe			
Ngelzarna A, Fune, Damaturu	5	30	148

Exploring Africa's untapped wind potential: Sean Whittaker, International Finance Corporation. (2020).

Source: **Oando Clean Energy, Global Wind Atlas and Vortex FDC**

Oando Clean Energy

National Wind Resource Map

Nigeria | 2025

www.oandocleanenergy.com

Conclusion

The global wind energy sector continues to experience significant growth surpassing 1 terawatt (TW) of installed capacity in 2023, with projections estimating 2.8TW by 2035, making it the second-largest renewable electricity source. China continues to lead global wind energy expansion, while Africa, despite abundant resources, lags due to infrastructure gaps, financing constraints, and policy inconsistencies.

Nigeria faces similar challenges, further compounded by insufficient wind resource data and research, limiting its ability to harness wind energy for electricity generation. Overcoming these barriers requires policy reforms, grid infrastructure developments, improved investment frameworks, and enhanced research efforts

Nigeria's Wind Energy Potential and Resource Assessment: Assessments using Global Wind Atlas and the Nigerian Meteorological Agency (NIMET) data reveal Nigeria's average wind speed of 6.79 m/s at 100m and a mean power density of 294 W/m², highlighting significant untapped potential.

Northern Nigeria - High Potential for Large-Scale Wind Farms: The Jos Plateau (Plateau State) and Mambilla Plateau (Taraba State) feature wind speeds exceeding 7 m/s, making them ideal for large-scale wind farms. Gombe, Plateau, and Taraba States have capacity and resources to host wind farms up to 225MW, positioning them as key potential investment sites.

Southern Nigeria - Viable Coastal and Inland Opportunities: Despite traditionally lower wind speeds at ground level, the southern and coastal regions of Nigeria also hold significant wind energy potential, particularly at elevated heights. The cumulative generation capacity in the coastal and Niger Delta areas is estimated at approximately 750MW.

Areas in Lagos like the Lekki Free Trade Zone and Eko Atlantic benefit from consistent coastal winds and proximity to major industrial and urban energy markets, making them ideal for wind energy integration. The Niger-Delta regions like Akwa Ibom and Bayelsa present viable wind energy opportunities, which could help diversify the economies of these oil-producing states while reducing carbon emissions and reliance on fossil fuels.

Despite existing studies, Nigeria lacks a nationally coordinated wind energy assessment. Further research should include:

- High-precision meteorological masts and LiDAR systems for extended wind measurements.
- Higher-resolution assessments of wind energy viability at different altitudes
- Economic feasibility studies to ensure project bankability.

By addressing these gaps, Nigeria can create a strong foundation for increased capital investment and large-scale development in its wind energy sector thus providing a feasible path towards energy diversification, renewable power generation, and long-term energy security.

At Oando, our ambition is to develop a combined 1GW wind energy infrastructure across multiple States in Nigeria, having already signed 175MW and 100MW wind energy infrastructure MoU with Edo and Cross River States respectively. We invite willing partners, with a common vision, to join us as we explore wind resources to close Nigeria's energy gap.

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