NET IMPACT DELHI UNIVERSITY

RENEWABLE ENERGY

INDUSTRY ANALYSIS REPORT 2025

CONTENTS

EXECUTIVE SUMMARY:

- The global renewable energy industry is at a pivotal point, driven by policy shifts, tech innovation, and rising climate concerns.
- The global renewable energy market size was estimated at USD 1.21 trillion in 2023 and is expected to grow at a compound annual growth rate (CAGR) of 17.2% from 2024 to 2030, and is projected to reach USD 5,080 billion by 2032,
- Solar and wind lead the charge, with hydropower and green hydrogen catching up.
- Challenges include intermittency, infrastructure gaps, and policy unpredictability.

KEY DRIVERS INCLUDE:

- Strong policy support in the EU, US (Inflation Reduction Act), and China
- Surging investments in solar and wind, along with energy storage
- Rapid technological advancements in grid management, AI, and hydrogen

INDUSTRY OVERVIEW:

Renewable energy refers to power derived from naturally replenishing resources such as sunlight, wind, rain, tides, and geothermal heat. Unlike fossil fuels, renewables produce minimal to no greenhouse gas emissions, making them central to global climate goals.

EVOLUTION OF THE INDUSTRY:

- 2000s: Renewables gained attention due to rising oil prices and climate awareness
- 2010s: Rapid growth in solar and wind due to falling costs and global pacts (e.g., Paris Agreement)
- 2020s: Mainstream adoption, tech maturity, and grid-scale integration

IMPORTANCE IN THE GLOBAL ECONOMY:

Renewable energy refers to power derived from naturally replenishing resources such as sunlight, wind, rain, tides, and geothermal heat. Unlike fossil fuels, renewables produce minimal to no greenhouse gas emissions, making them central to global climate goals.

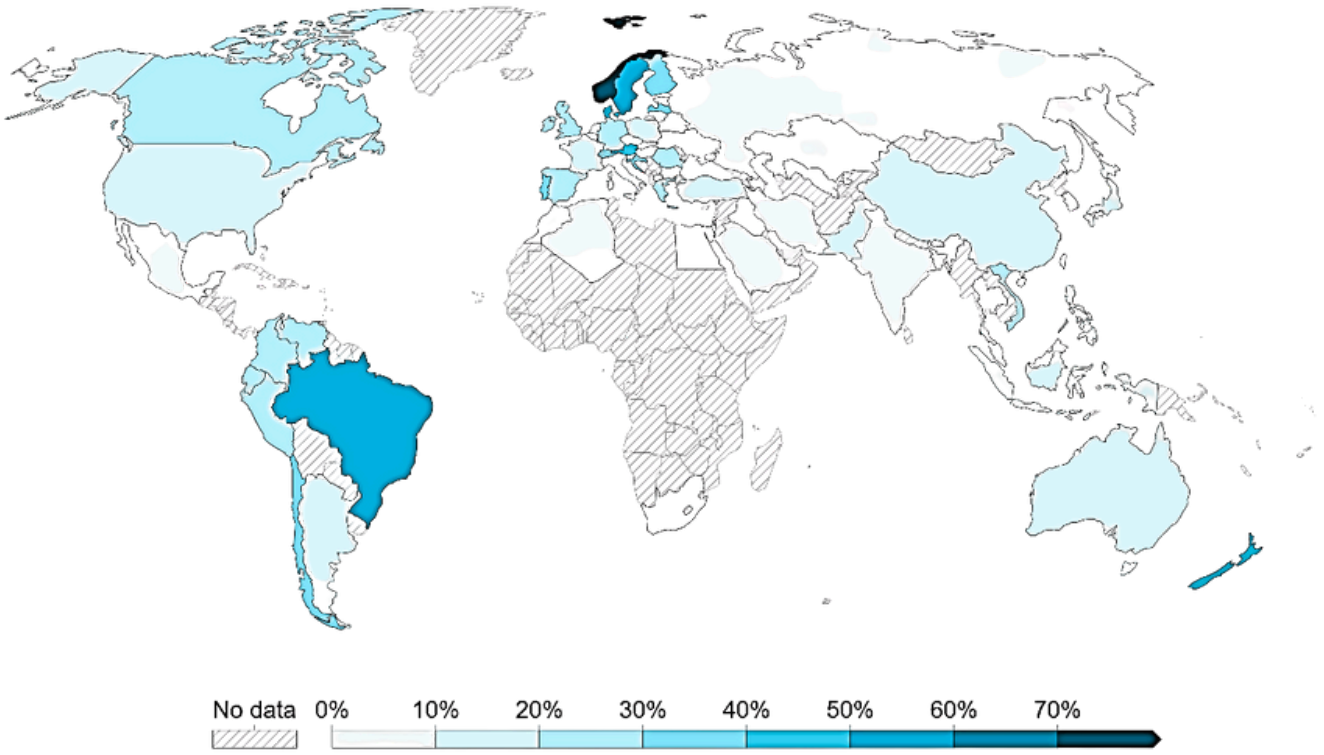
MARKET SIZE AND GROWTH

- The first chart shows this as a stacked area chart, which allows us to more readily see the breakdown of the renewable mix and the relative contribution of each. The second chart is shown as a line chart, allowing us to see more clearly how each source is changing over time.
- Globally, we see that hydropower is by far the largest modern renewable source. However, we also see wind and solar power both growing rapidly.

Share of primary energy consumption from renewable sources, 2023

Our World in Data

Measured as a percentage of primary energy[1] using the substitution method[2]. Renewables include hydropower, solar, wind, geothermal, bioenergy, wave, and tidal, but not traditional biofuels, which can be a key energy source, especially in lower-income settings.



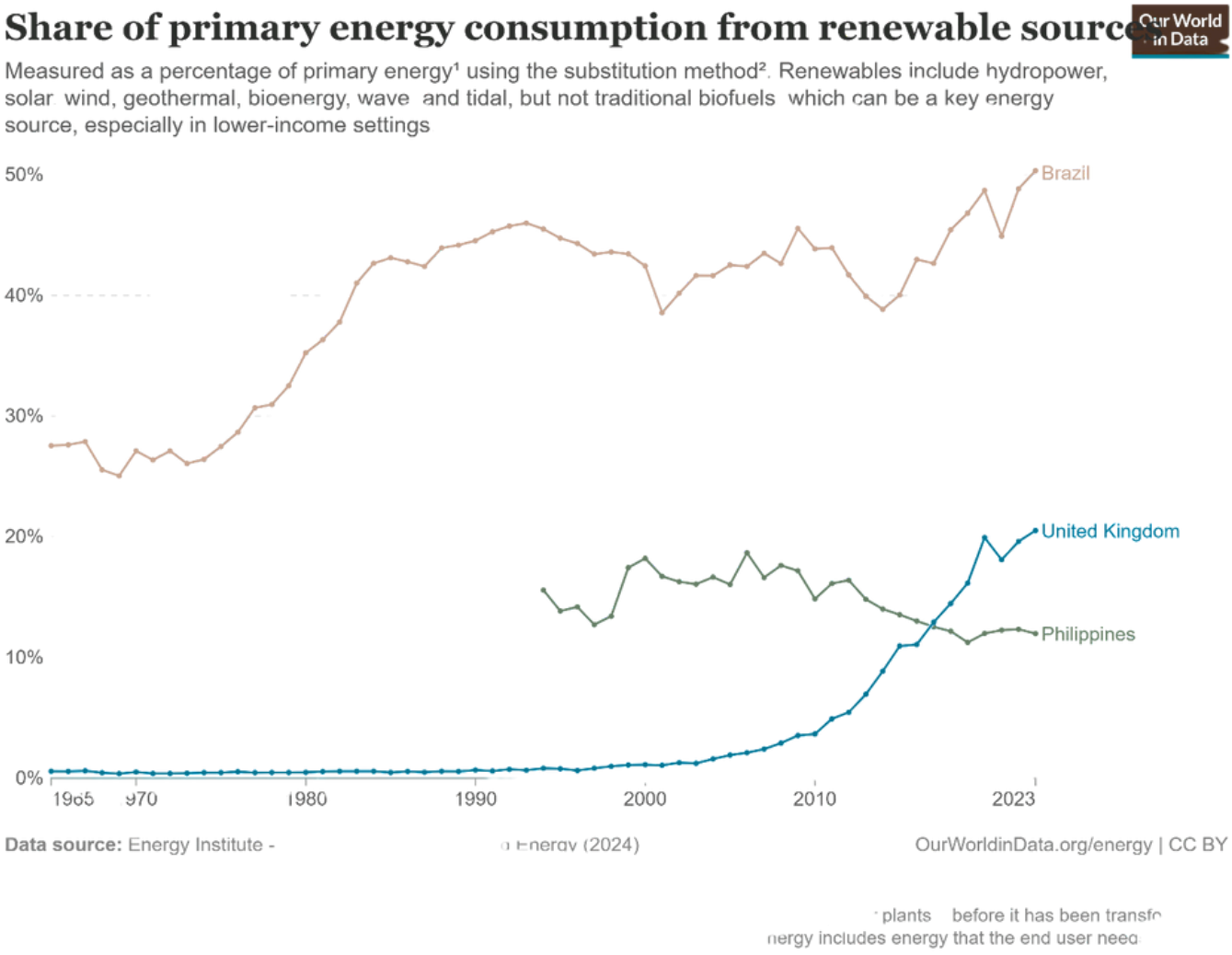
Data source: Energy Institute - Statistical Review of World Energy (2024)

OurWorldinData.org/energy | CC BY

1. Primary energy: Primary energy is the energy available as resources – such as the fuels burnt in power plants – before it has been transformed. This relates to the coal before it has been burned, the uranium, or the barrels of oil. Primary energy includes energy that the end user needs, in the form of electricity, transport and heating, plus inefficiencies and energy that is lost when raw resources are transformed into a usable form. You can read more on the different ways of measuring energy in our article.

2. Substitution method: The 'substitution method' is used by researchers to correct primary energy consumption for efficiency losses experienced by fossil fuels. It tries to adjust non-fossil energy sources to the inputs that would be needed if it was generated from fossil fuels. It assumes that wind and solar electricity is as inefficient as coal or gas. To do this, energy generation from non-fossil sources are divided by a standard 'thermal efficiency factor' – typically around 0.4 Nuclear power is also adjusted despite it also experiencing thermal losses in a power plant. Since it's reported in terms of electricity output, we need to do this adjustment to calculate its equivalent input value. You can read more about this adjustment in our article.

MARKET SIZE AND GROWTH



plants before it has been transfo
nergy includes energy that the end user need

KEY SEGMENTS AND SUB-SECTORS

The renewable energy industry comprises several key segments based on the source of energy generation. Each segment contributes differently regarding market share, growth rate, and technological maturity.

Segment	2023 Market Share (%)	Key Trends
Solar	44%	Rooftop solar, bifacial panels, PPA models
Wind	28%	Offshore wind, floating wind farms
Hydropower	19%	Small hydro, pumped storage
Bioenergy	06%	Biomass, biofuels, waste-to-energy
Geothermal	03%	Direct heating, binary cycle plants

SUB-SECTORS (ACROSS TECHNOLOGIES):

- Utility-scale vs Rooftop (Solar)
- Onshore vs Offshore (Wind)
- Green Hydrogen (gaining traction as a storage and transport solution)
- Energy Storage (integrated with renewables for grid stability)

COMPETITIVE LANDSCAPE

The global renewable energy industry is led by a mix of energy giants, specialised clean-tech firms, and fast-growing innovators.

MAJOR PLAYERS:

Company	**Country**	**Area of Focus**
NextEra Energy	USA	Wind + Solar + Storage
Ørsted	Denmark	Offshore Wind
Iberdrola	Spain	Wind + Hydro + Green Hydro
Enel Green Power	Italy	Wind, Solar, Geothermal
Vestas	Denmark	Wind Turbine Manufacturing
LONGi Green Energy	China	Solar Manufacturing

MARKET SHARE INSIGHTS:

- Top 10 players account for ~35% of the global renewable energy capacity.
- China alone contributes over 50% of new solar and wind installations annually

MERGERS & ACQUISATIONS:

- Ørsted acquired Deepwater Wind (U.S.) to strengthen offshore wind operations
- Brookfield Renewable Partners continues aggressive acquisition of solar developers globally.

ENTRY BARRIERS:

- High capital investment, long payback periods
- Policy/regulatory dependency in most countries
- Technology standardisation challenges

REVENUE STREAMS

Companies in the renewable energy sector generate revenue through several established and emerging business models.

PRIMARY REVENUE SOURCES:

Stream	Description
Power Purchase Agreements (PPAS)	Long-term contracts to sell electricity to utilities or corporations
Government Incentives	Feed-in tariffs, subsidies, tax credits (e.g., U.S. IRA Act)
Direct-to-Consumer (Retail Energy Sales)	Selling power to end consumers, especially in deregulated markets
Carbon Credits & Green Certificates	Selling emission reduction credits and renewable energy certificates (RECs)
Energy-as-a-Service	Subscription-based solar systems or storage as a service

EMERGING BUSINESS MODELS:

- Virtual Power Plants (VPPs): Aggregated renewable and storage systems to trade energy on the grid
- Battery Leasing & Storage-as-a-Service
- Peer-to-peer Energy Trading using blockchain platforms (pilot projects in Europe and Australia)

PRICING STRATEGIES:

- Time-of-use pricing to capitalize on peak demand hours
- Auction-based pricing in government tenders (e.g., lowest-cost bids for large-scale projects)
- Net metering and feed-in tariffs for residential and commercial customers

COST STRUCTURE

The renewable energy industry's cost structure varies by technology and region but generally includes high upfront capital expenditure and lower operating costs.

MAJOR COST DRIVERS:

Category	% of Total Cost (approx.)	Notes
Equipment	40–50%	Turbines, panels, batteries
Installation & Construction	20–30%	Labor, grid integration
Operations & Maintenance (O&M)	10–20%	Monitoring, repairs, cleaning
Land & Permits	5–10%	Site acquisition, approvals
Financing Costs	Varies	Loans, insurance , interest payments

OPERATIONAL EFFICIENCY:

- Solar LCOE (Levelized Cost of Electricity) dropped by 89% between 2010 and 2023
- Wind LCOE decreased by 70% during the same period.

MARGINS ARE IMPROVING DUE TO:

- Economies of scale
- Vertical integration by manufacturers (e.g., LONGi, Vestas)
- Government-backed low-interest loans

VALUE CHAIN ANALYSIS

The renewable energy value chain consists of several interconnected stages — from raw materials to power delivery. Each stage presents opportunities for innovation and value creation.

END-TO-END FLOW:

Raw Material Extraction ➜ Equipment Manufacturing ➜ Project Development ➜ Power Generation ➜ Grid Integration ➜ Distribution to End Users

1. Raw Material Extraction
   - Silicon, lithium, copper, rare earths
   - Sourced mainly from China, Chile, Australia, DRC

2. Component Manufacturing
   - Solar panels (LONGi, JA Solar), wind turbines (Vestas, Siemens Gamesa)
   - Inverters, batteries, trackers, control systems

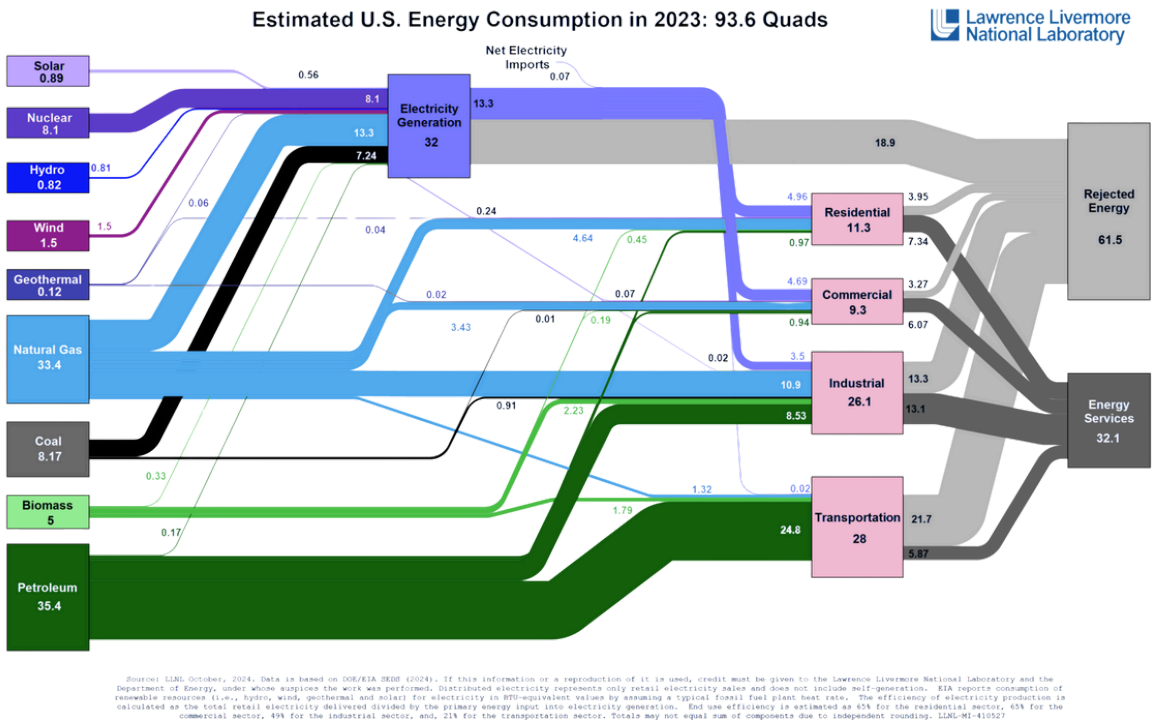
3. Project Development & EPC (Engineering, Procurement, Construction)
   - Site selection, permitting, grid connection
   - EPC firms like Bechtel, Fluor, Adani Infra

4. Financing & Insurance
   - Green bonds, VC/PE funds, sovereign wealth
   - Risk mitigation from insurers & DFIs (Development Finance Institutions)

5. Power Generation & Operation
   - Utility-scale, distributed or hybrid systems
   - Real-time monitoring & predictive maintenance

6. Transmission & Distribution
   - Smart grids, interconnectors, storage integration
   - Utility companies like PG&E, National Grid

7. Energy Retail & End Consumption
   - Direct to households, businesses, and industries
   - PPAs, retail plans, net-metering systems



KEY STAGES EXPLAINED:

Stage	Description	Major Players
Raw Materials	Mining of rare earths, silicon, lithium, copper	Albemarle (lithium), China Northern Rare Earth
Manufacturing	Solar panels, turbines, batteries	LONGi, Vestas, Siemens Gamesa, CATL
Project Development	Land acquisition, permitting, financing	Ørsted, NextEra, Brookfield Renewables
Power Generation	Operating renewable assets	Enel Green Power, Iberdrola
Grid Connection	Integrating power into national grids	National grid operators, transmission companies
Distribution & Sales	Selling electricity via utilities, PPAs, or direct	Utilities, startups (e.g., Octopus Energy)

PROFIT MARGINS AT EACH STAGE:

Stage	Profit Margin Range	Notes
Manufacturing	8–15%	Economies of scale important
Project Development	10–20%	Higher risk, higher return
Power Generation (O&M)	25–40%	Low ongoing costs, steady returns
Distribution	5–10%	Regulated in many regions

TRENDS AND INNOVATIONS

The renewable energy value chain consists of several interconnected stages — from raw materials to power delivery. Each stage presents opportunities for innovation and value creation.

TECHNOLOGICAL ADVANCEMENTS:

- Next-Gen Solar: Emergence of perovskite solar cells with >30% efficiency potential
- Offshore Wind: Floating wind farms allow deployment in deeper waters. Global floating capacity expected to reach 10 GW by 2030
- Green Hydrogen: Electrolyser costs declined by 50% since 2020; projected to fall another 60% by 2030

DIGITAL TRANSFORMATION:

- AI & IoT for predictive maintenance in wind/solar farms
- Blockchain for peer-to-peer energy trading and real-time grid transparency
- Digital Twins are used to simulate and optimise renewable asset performance

ESG AND SUSTAINABILITY:

- Sustainability reporting is now mandatory in the EU under CSRD regulations for renewable energy companies
- Rise in carbon-negative projects (e.g., bioenergy with carbon capture)
- 75% of investors globally now consider ESG impact before funding clean energy firms

EMERGING CONSUMPTION PATTERNS:

- Surge in community solar models and co-owned wind farms
- Rising corporate clean power purchase agreements (PPAS) – with global capacity addition via corporate PPAS reaching 46 GW in 2023, up 12% YoY

REGULATORY ENVIRONMENT

- The renewable energy industry is significantly influenced by government policies, international agreements, and regulatory frameworks designed to promote a sustainable energy transition.

KEY POLICIES AND REFORMS:

- Inflation Reduction Act (USA, 2022): Provides ~$370 billion in clean energy tax incentives and subsidies
- REPowerEU Plan (EU, 2023): Aims for 45% renewable energy share in total energy mix by 2030
- China's 14th Five-Year Plan (2021–2025): Targets over 1,200 GW of wind and solar by 2030; by 2023, the country had already reached 1,000 GW
- International Agreements: The Paris Agreement and COP28 outcomes continue to shape long-term regulatory goals

LICENSING & COMPLIANCE:

Region	Licensing Requirement	Notes
EU	Streamlined permitting under RED III	2-year maximum for wind/solar grid approvals
USA	Federal Energy Regulatory Commission (FERC)	Environmental and interconnection approvals
India	State-level approvals for land and grid use	Relevant for multinationals entering Indian RE market

TAXATION & FINANCIAL INCENTIVES:

- Production & Investment Tax Credits (PTC & ITC) in the U.S. for wind and solar (up to 30% credit)
- VAT Exemptions/Subsidies for equipment in countries like Germany, China, and Brazil
- Carbon pricing mechanisms in over 70 countries, influencing renewable competitiveness

CHALLENGES AND RISKS

Despite rapid growth, the renewable energy industry grapples with several headwinds that could affect its long-term sustainability and scalability.

INDUSTRY-SPECIFIC RISKS:

Risk	Description
Intermittency	Solar and wind depend on weather; the need for large scale storage remains unmet
Supply Chain Disruptions	Over-dependence on China for solar modules, rare earths, and batteries
Land Acquisition Issues	Utility-scale projects often face delays due to land disputes and zoning
Grid Integration	Legacy grids in many countries can't handle variable renewable energy flows

SWOT ANALYSIS:

Strengths	Weaknesses
Zero emissions, public support, falling costs	Intermittency, storage issues, capital intensity
Opportunities	Threats
Green hydrogen, emerging markets, digitalisation	Geopolitical instability, policy reversals, and material scarcity

PESTLE ANALYSIS:

Factor	Example
Political	Subsidy policy shifts (e.g., UK subsidy cuts in 2023)
Economic	High upfront CAPEX despite falling long-term LCOE
Social	Community resistance to large land-based projects
Technological	Battery innovation, smart grid integration
Legal	Regulatory inconsistencies across regions
Environmental	Mining of rare earths for RE tech impacting ecosystems

INVESTMENT LANDSCAPE:

Investor interest in renewables is at an all-time high, driven by ESG mandates, regulatory push, and high returns over the long term.

VC/PE ACTIVITY:

- Global clean energy startups raised over $60 billion in VC/PE funding in 2023, a 25% YoY increase
- Major focus areas include battery tech, hydrogen, carbon capture, and AI-powered energy platforms

FDI INFLOWS:

Renewable energy remained the largest sector for global FDI in energy, accounting for over 55% of all energy-related greenfield investments in 2023
Top destinations: U.S., Germany, India, Brazil

M&A TRENDS:

- Over 280 M&A deals in the global renewables sector in 2023, valued at $180 billion
- Notable deals: Shell acquiring Nature Energy (biogas), Brookfield investing in Scout Clean Energy (wind)

PUBLIC MARKET PERFORMANCE:

- Renewable ETFS like iShares Global Clean Energy (ICLN) showed a 12% gain in 2023, rebounding from 2022 lows
- IPOs include Clēnera, Heliogen, and Redaptive in solar and energy efficiency

GLOBAL PERSPECTIVE

The global renewable energy industry is expanding at varying paces across regions, influenced by policy, resources, and infrastructure maturity.

REGIONAL COMPARISON SNAPSHOT:

Region	Highlights
Europe	Leading in offshore wind and solar PV adoption; EU's REPowerEU targets 45% RE share by 2030
North America	U.S. Inflation Reduction Act boosting investment; Canada focuses on hydro and wind development
Asia-Pacific	China dominates global RE capacity (1,000+ GW in 2023); India ranks 4th globally in installed RE capacity
Africa	Low adoption (~2% global share), but high potential; initiatives include Desert to Power and AfDB funding
Latin America	High share of renewables in power mix (hydro-heavy); Brazil and Chile advancing in wind and solar

INDIA'S POSITION GLOBALLY:

- 4th largest in renewable installed capacity (as of 2023) with over 180 GW
- Target: 500 GW non-fossil capacity by 2030, part of its COP26 commitment

CASE STUDIES / RECENT DEVELOPMENTS

This section highlights notable strategies, company pivots, and global disruptions that shaped the renewable energy industry in 2023–24.

CASE STUDY 1: AMAZON'S RENEWABLE ENERGY LEADERSHIP

- Amazon became the world's largest corporate buyer of renewable energy, with 479 renewable projects globally totalling 24.2 GW by 2023
- These include utility-scale solar and wind projects across 27 countries, supporting Amazon's target to power operations with 100% renewables by 2025

CASE STUDY 2: TESLA MEGAPACK IN AUSTRALIA

- Tesla deployed a 150 MW/300 MWh Megapack battery project in Victoria, Australia in 2023, stabilizing the grid and reducing blackout risks
- Marked a major leap in grid-scale storage, enabling better RE integration

RECENT DEVELOPMENT: EU GREEN DEAL INDUSTRIAL PLAN

Announced in 2023 to boost clean tech manufacturing and cut red tape

Aims to match the U.S. Inflation Reduction Act's ~$369B incentives

DISRUPTION: RARE EARTH PRICE SURGE

In 2023, rare earth materials like lithium and cobalt saw price hikes due to geopolitical tensions, impacting battery and solar panel costs

KEY PERFORMANCE INDICATORS (KPIS)

These indicators help assess operational efficiency, growth, and economic impact across various renewable energy industry segments.

INSTALLED CAPACITY

Total global installed renewable capacity reached 3,870 GW in 2023, led by solar (37%) and wind (30%)

CAPACITY UTILISATION FACTOR (CUF)

Solar PV CUF averages around 18–22%, while wind CUF globally is between 30–35%, varying by geography and technology

RENEWABLES SHARE IN GLOBAL POWER MIX

Renewables generated 30% of global electricity in 2023, up from 28% in 2022

LEVELIZED COST OF ENERGY (LCOE)

In 2023:

- Solar PV: $0.04/kWh
- Onshore Wind: $0.03–0.06/kWh

BATTERY STORAGE DEPLOYMENT

- Global battery storage capacity surged to 73 GWh in 2023, up 85% YoY, primarily in the U.S., China, and Europe

FUTURE OUTLOOK

The renewable energy sector is set for unprecedented global expansion, driven by policy support, technological innovation, and cost declines.

PROJECTIONS & GROWTH ENABLERS:

- Global renewable capacity is expected to reach 7,300 GW by 2028, nearly doubling from 2023 levels
- Solar PV will account for over 60% of this increase, followed by wind (25%)
- Key enablers:
  - Continued fall in LCOE (Levelized Cost of Electricity)
  - Government targets & climate pledges (e.g. Net Zero by 2050)
  - Energy security push post geopolitical tensions

POTENTIAL HEADWINDS:

- Rising costs of critical minerals (lithium, cobalt, rare earths)
- Land acquisition delays & permitting bottlenecks
- Supply chain disruptions and skilled workforce shortages

ANALYST FORECASTS:

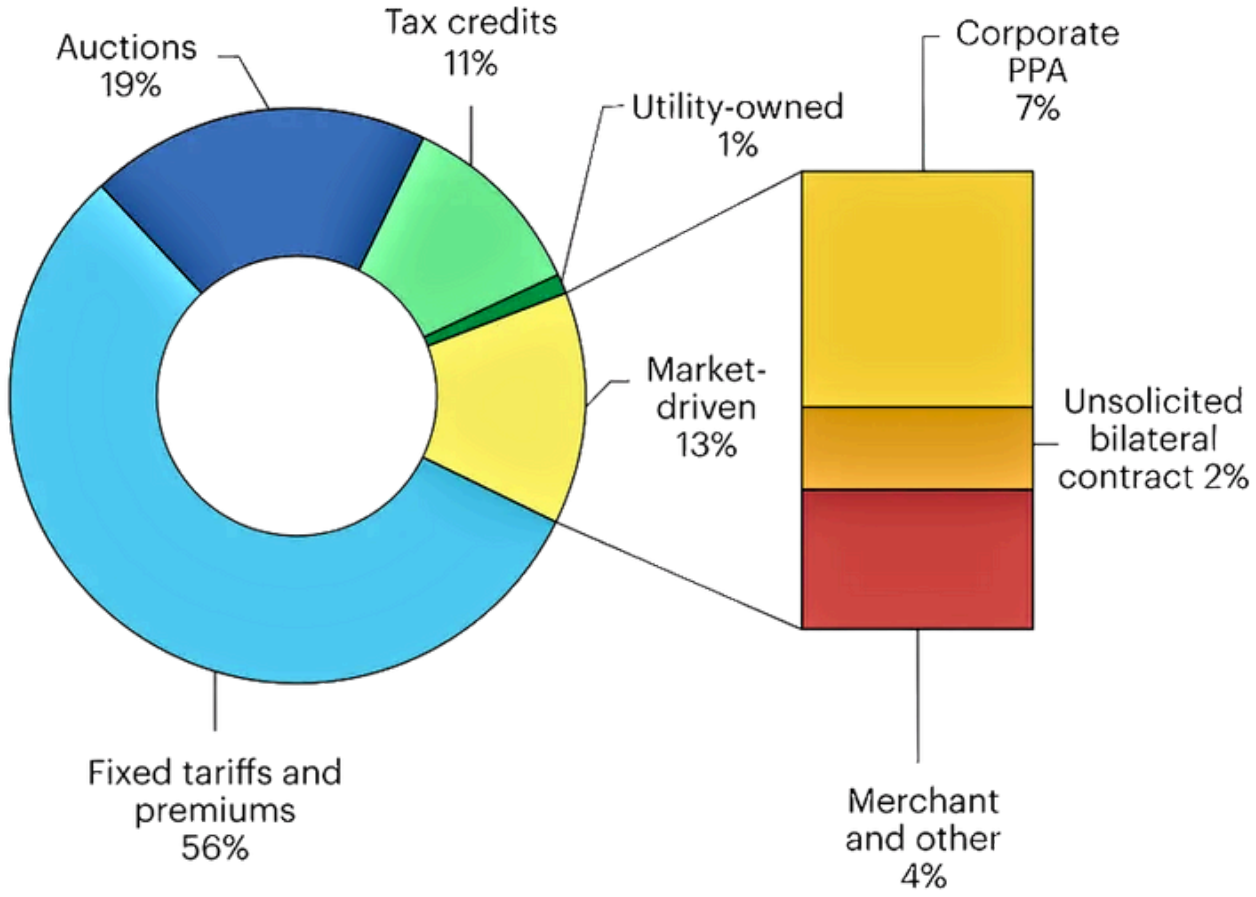
The global renewable energy market is projected to grow at a CAGR of 9.6%, reaching over USD 2 trillion by 2032

CONCLUSION

The renewable energy industry is at an inflexion point, driven by policy, innovation, and the rising urgency of climate action. While challenges such as grid integration, mineral dependency, and permitting delays persist, the long-term outlook remains bullish. Stakeholders—governments, investors, and corporations—are doubling down, making renewables not just an environmental imperative but a central economic growth engine.

APPENDIX

CHARTS & GRAPHS



GLOBAL RENEWABLE INSTALLED CAPACITY (2023–2028 FORECAST)

This graph illustrates the projected global renewable energy capacity increase, nearly doubling by 2028. Solar energy leads the growth, followed by wind and hydropower expansions

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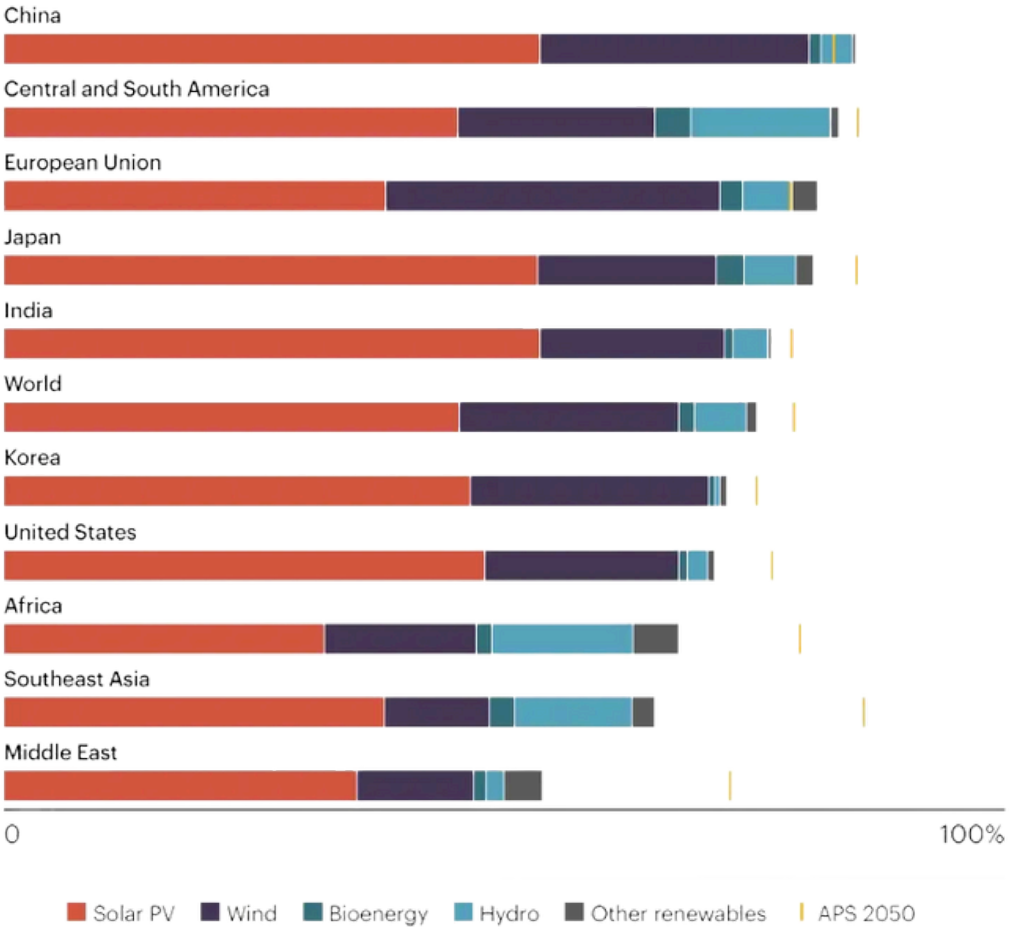
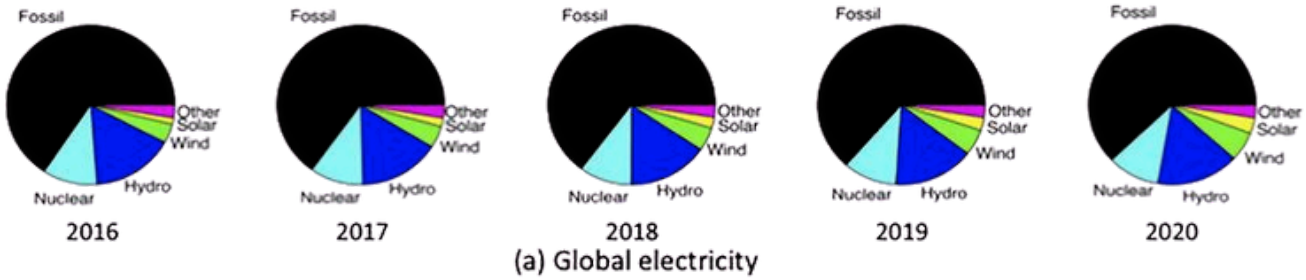


REGIONAL RENEWABLE CAPACITY COMPARISON

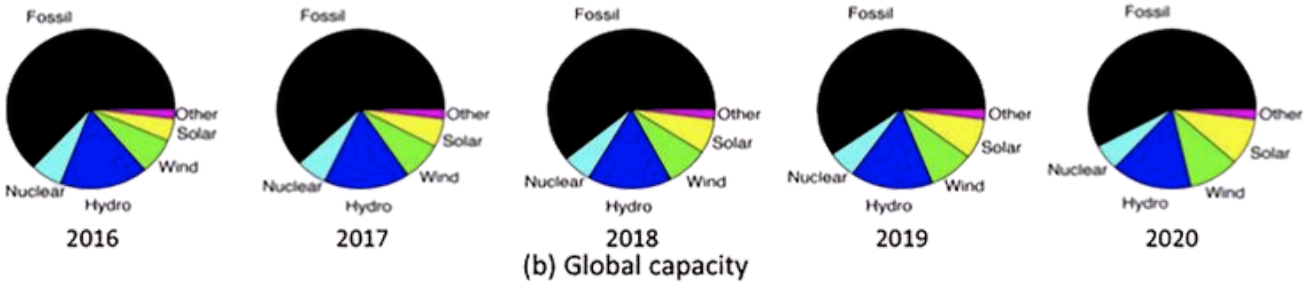
This chart compares renewable energy capacities across regions, showing China's dominance, followed by Europe and North America. Africa lags but shows high growth potential.

APPENDIX

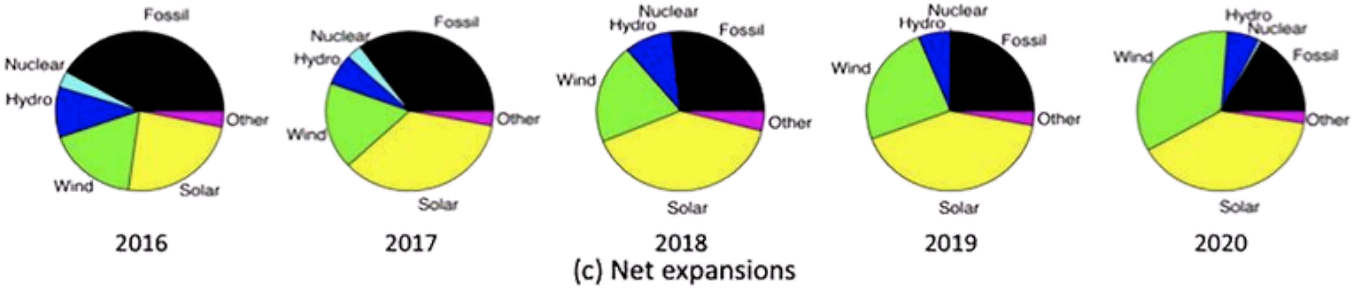
CHARTS & GRAPHS



(a) Global electricity



(b) Global capacity



(c) Net expansions

MARKET SHARE BY TECHNOLOGY

The pie chart displays the 2023 market share of renewable sources, with solar (44%) and wind (28%) leading. Hydropower, bioenergy, and geothermal together form the remaining 28%.

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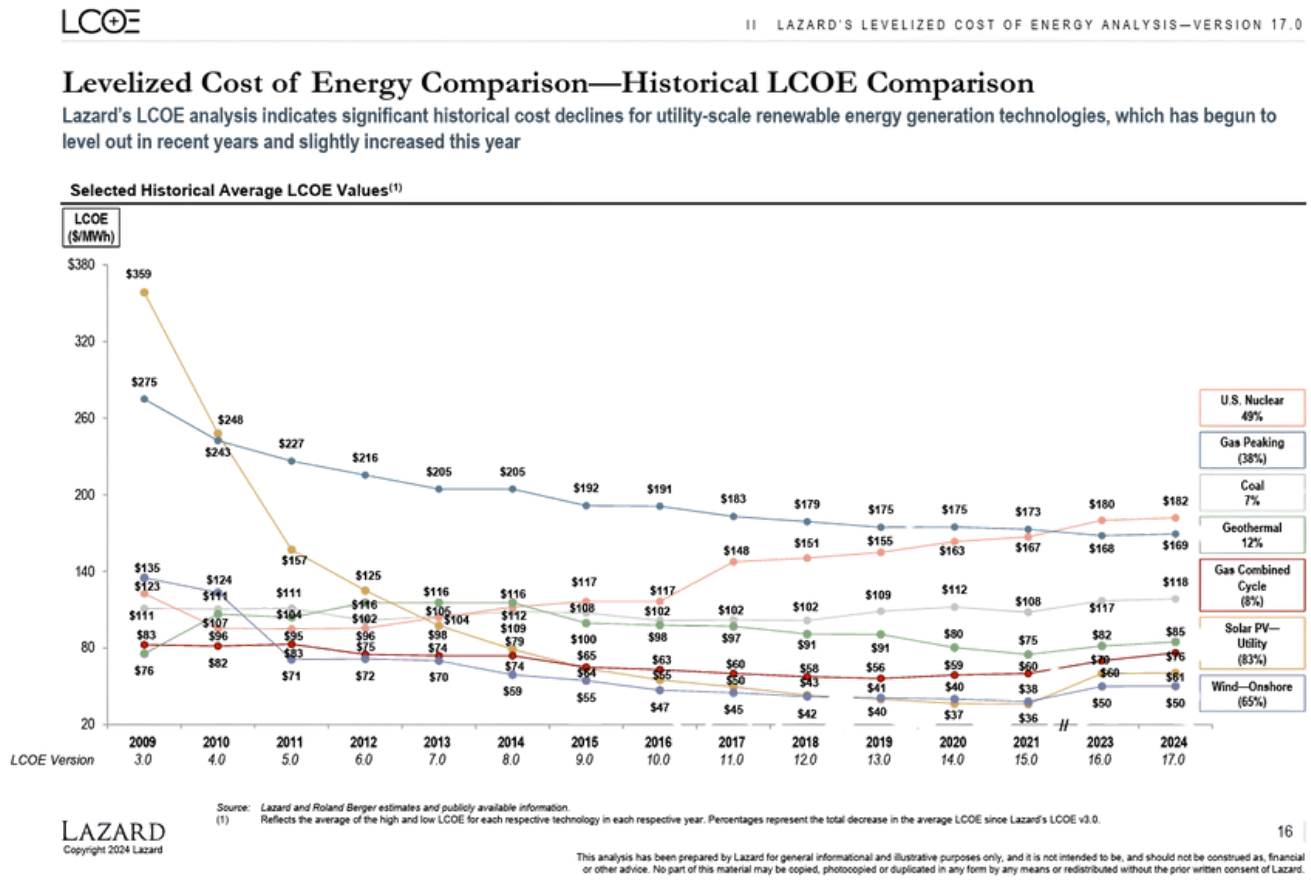

LCOE TREND (2015–2023)

This line graph tracks the decline in the Levelized Cost of Energy for solar and wind from 2015 to 2023. It highlights improved cost efficiency due to technological advancements and scale.

SOURCE LIST / REFERENCES:

- LCOE – Levelized Cost of Energy
- CUF – Capacity Utilisation Factor
- GW/GWh – Gigawatt / Gigawatt-hour
- IEA – International Energy Agency
- ESG – Environmental, Social, Governance
- PPA – Power Purchase Agreement
- IRA – Inflation Reduction Act

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