FutureBridge

TECHNOLOGY INNOVATIONS

Disruptive Forces in Renewable Power Generation

Global Renewable Power Generation

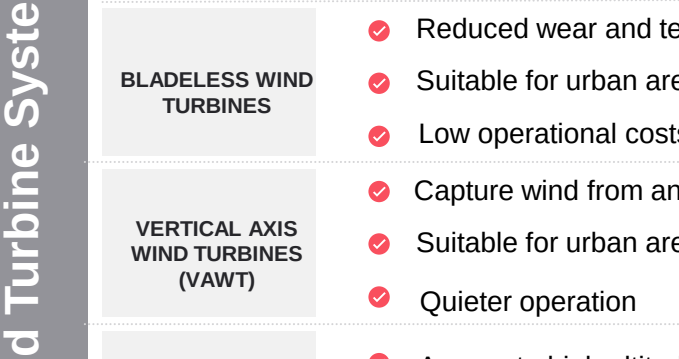
Global Market Size and Forecast

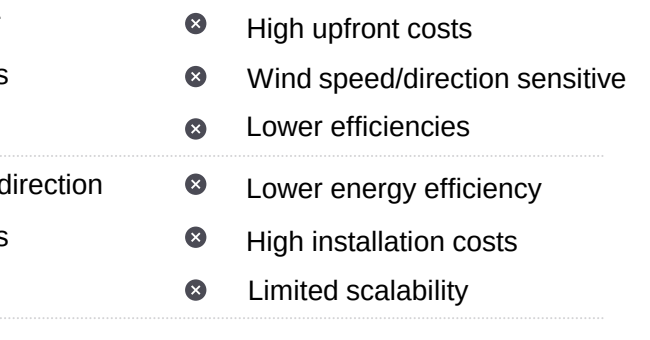
8,500 TWh — 2023

16,000 TWh — 2030F

By **2030**, solar and wind energy generation will surge **3X**, powering a sustainable energy future

Technological innovations across the value chain are **powering** this unprecedented growth, projected to reach **$23 trillion** by 2030*





*energy.gov

Technological Innovations in Solar Power Generation

Solar Panels

	BENEFITS	DOWNSIDES
PEROVSKITE SOLAR PANELS	Higher efficiency Lightweight Lower cost	Stability issues Shorter life span High toxicity potential
BI-FACIAL SOLAR PANELS	Higher efficiency Improved land use Optimized for reflection	Elevated capital expenditure Environment dependency
TEXTURED SOLAR PANELS	Higher efficiency Captures more daylight Enhanced low light performance	Heavy cost implications Advanced production techniques
GRAPHENE-BASED ELECTRODES	More conductive Lightweight Increased life span	Significant costs Scalability issues Low TRL technology

Perovskite solar panels are poised to redefine the future of renewable energy, offering unprecedented efficiencies and cost effectiveness

Smart Innovations in Wind Energy

Wind Turbine Systems

	BENEFITS	DOWNSIDES
FLOATING WIND TURBINE SYSTEMS	Access to deeper waters Reduced visual impact Suitable for locations with strong winds	High development costs Limited scalability Complex installation
BLADELESS WIND TURBINES	Reduced wear and tear Suitable for urban areas Low operational costs	High upfront costs Wind speed/direction sensitive Lower efficiencies
VERTICAL AXIS WIND TURBINES (VAWT)	Capture wind from any direction Suitable for urban areas Quieter operation	Lower energy efficiency High installation costs Limited scalability
AIRBORNE WIND ENERGY	Access to high altitude winds Portable and Flexible Cost-effective	Energy transmission issues Regulatory Challenges Early stages of development

Vertical Axis Wind Turbines (VAWT) have proven to be 15% more efficient than traditional HAWTs in case of offshore wind power generation

Comparing Energy Storage Innovations

Battery Energy Storage Systems (BESS)

	BENEFITS	DOWNSIDES
FLOW BATTERY	Long cycle life Scalable Non explosive components	High capital cost Large physical size Not suitable for residential
MOLTEN SALT	Long duration High energy density High life span	High operating temperature Slow charging/discharging rates Not suitable for residential
SOLID STATE	High Energy Density Faster charging rates Compact Design	High cost of production Low TRL technology Uncertain long-term performance
SODIUM/ MAGENISIUM ION	High energy density Safer than lithium-ion High lifespan	Limited commercial development Lower conductivity Slow charge/discharge cycles

Redox Flow Batteries are revolutionizing energy storage, offering scalable, long-lasting and safe solutions for grid-scale renewable integration

Artificial Intelligence (AI) Adoption in Renewable Power

AI Use Cases

	USE CASE	EXAMPLE
Predictive Maintenance	AI based systems use data from sensors on wind turbines, solar panels and batteries to predict failures before they happen	**Siemens Gamesa** uses AI algorithms to predict failures in wind turbines, allowing maintenance only when necessary
AI Optimized Storage	AI models analyze vast data from weather forecasts, and historical energy consumption, to accurately predict energy demand/generation, thereby optimizing renewable energy storage.	**Capalo AI,** a Finland based startup, utilizes AI to predict renewable power generation and consumption to optimize battery storage and maximize grid benefits
AI Powered Grid Management	AI assists in the real-time management of electricity flows across multiple sources and consumers, ensuring stable operation in hybrid renewable energy grids	**Open Power AI Consortium,** is developing AI models and datasets to enhance electricity grid efficiency and reliability
AI in Wind Turbine Design	AI technologies are being applied in the design and testing of wind turbines, helping optimize blade shapes and improve aerodynamics	**GE Vernova** uses AI to optimize turbine designs to boost wind energy production efficiency

AI is transforming grid management, enhancing stability, accelerating clean energy integration, and driving intelligent energy optimization.

Conclusion

- Investing in next-gen solar panels and advanced wind turbines can **boost efficiency by 25% and cut costs by 30%**, helping companies lead in the growing renewables market.
- Innovations like **floating wind turbines and agrivoltaic systems reduce land use and environmental impact, while supporting sustainability goals** and investor appeal.
- Energy storage is key to renewable power integration, with **Redox Flow and Solid-State Batteries** enabling **more efficient, cost-effective management** of intermittent clean energy sources.
- With **solar and wind generation expected to triple by 2030**, companies investing in innovation today are well-positioned to capture future market share.

About FutureBridge

FutureBridge is a techno-commercial consulting and advisory company. We track and advise on the future of industries from a 1-to-25-year perspective to keep you ahead of the technology curve, propel your growth, Identify new opportunities, markets and business models, answer your unknowns, and facilitate best-fit solutions and partnerships using our platforms, programs, and access to global ecosystems and players.