Unlocking the next wave of renewable energy with AI

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As the world races to meet surging electricity demand and net zero targets, artificial intelligence is emerging as a critical enabler in the renewable energy transition. From stabilising solar output to powering intelligent microgrids and slashing energy waste across industries, AI and IoT technologies are transforming how we generate, distribute and consume clean electricity.

As global electricity demand is expected to grow by 3.4% annually through 2026, driven by mass electrification and digitalisation, the strain on our existing power infrastructure is mounting. The International Energy Agency (IEA) estimates that the world must add or replace 80 million kilometres of power lines, or roughly everything that exists today, by 2040 to accommodate the surge.

This massive overhaul is not just an engineering challenge; it is a race against time, especially as energy demand is being reshaped by data centres, electric vehicles and digitised economies across Asia and beyond.

To complicate matters further, solar power is being deployed at a record pace as global leaders pledged to triple renewable energy capacity to at least 11,000 GW by 2030. While this signals progress, their success magnifies a fundamental technical weakness: intermittency. To keep grids stable while we chase net zero goals, nations must learn not just to deploy more renewable capacity but to orchestrate it hour by hour and second by second.

That is precisely where artificial intelligence (AI) and the Internet of Things (IoT) are proving catalytic. No longer experimental, they are already helping companies cut energy costs, boost resilience and lower carbon emissions while making every sun electron count.

Smarter renewables: from intermittent to intelligent

AI is stripping away one of the biggest historical barriers to renewable adoption: unpredictability.

By crunching high resolution weather data, learning local micro-climates and running physics-informed neural networks, AI improves real-time forecasts for solar irradiance. According to the International Renewable Energy Agency (IRENA), better forecasts can increase forecast accuracy by up to 30%, shrinking balancing costs and making renewables more competitive.

This intelligence also helps grid operators and energy traders better manage supply-demand balance, reduce curtailment and lower reliance on fossil fuel backup. A Fortune Global 500 energy operator used AI to manage a vast portfolio of renewable energy assets spread across multiple geographies. By connecting disparate systems and applying predictive analytics, they improved energy output, reduced downtime and streamlined participation in energy markets. The result: an estimated 8 to 10 times return on investment, driven by improved asset performance, operational efficiency, and smarter trading strategies. This proves that data does not just monitor but also multiplies the impact of every kilowatt generated.

Crucially, AI also helps grid operators. When a cold front throttles solar production, algorithms can pre-emptively re-dispatch flexible gas units, spin up battery storage or call on demand-response fleets. That proactive balancing reduces the need for fossil-fuel 'just in case' reserves, letting more variable renewables run at full tilt. This real-time responsiveness transforms renewables from passive contributors to active participants in grid reliability.

Put simply, AI is not just enabling more renewables, it's making them smarter, cheaper and easier to scale. As grid complexity increases, that intelligence becomes essential.

AI for energy efficiency at scale

Generation is only half the story. AI is equally disruptive on the demand side, squeezing more value out of every clean kilowatt produced by solar.

From smart homes to commercial buildings, AI-driven control platforms sample millions of sensor points including temperature, occupancy and asset condition, and issue micro-adjustments to HVAC, lighting and process equipment in real time. Because the software 'learns' building thermodynamics and user comfort thresholds, savings accrue without anyone noticing the tweaks.

Retailers, logistics companies and manufacturers are already seeing results. One leading European insurer reduced energy consumption by 36% within a month by using AI to manage energy across its property portfolio.

Meanwhile, a global commercial property group, managing mixed-use buildings, saw a 16% reduction in energy use, achieving full return period in under four months. In both cases, savings were achieved without installing new hardware, just by turning data into decisions.

For heavy industry, AI tunes variable-speed drives, kilns and refrigeration systems to avoid coincident demand spikes that typically occur when clouds pass over a large solar array. This prevents unnecessary strain on the grid and lowers peak demand charges, a major cost factor in industrial operations.

Organisations that embrace AI as a foundational enabler will be best placed to deliver on climate commitments, maintain reliability and unlock new value streams.

By timing non-critical loads to dovetail with local solar output, factories increase the share of carbon-free power in their mix while sidestepping demand charges.

AI-orchestrated microgrids for energy independence

Climate-driven weather extremes and chronic grid congestion are pushing commercial and public sector entities to adopt AI-controlled microgrids, miniature power systems that can run in tandem with, or islanded from, the main grid. At their heart lie solar arrays, battery storage and intelligent inverters linked by real-time optimisation engines.

Consider a European supermarket chain facing both grid bottlenecks and volatile wholesale prices. By installing rooftop solar, a car-park canopy array, 2 MWh of lithium-ion storage and an AI orchestration layer, the retailer now curtails grid imports during midday solar peaks, arbitrages excess generation into evening demand and provides ancillary services back to the utility. The result: lower bills, fewer blackouts and a quantified cut in Scope 2 emissions.

Across Europe and Asia, microgrids are becoming a foundational strategy for energy reliability, especially in rural areas where traditional grid upgrades are slow or even infeasible.

Beyond resilience, microgrids unlock financial value. In deregulated markets, AI aggregates spare solar capacity across campus microgrids and bids that virtual power plant (VPP) into frequency-response and reserve markets, a practice increasingly enabled by deregulated market access and advanced forecasting tools. Early movers are earning six-figure annual incomes for energy services once monopolised by large thermal plants. This income can then be reinvested into further decarbonisation or used to hedge against future volatility.

Bridging the energy trilemma

Collectively, these AI-centred use-cases chip away at what the World Energy Council calls the enduring energy trilemma: how to supply secure electricity, meaning always available, affordable and equitable, priced so households and industries can thrive and environmentally sustainable, being aligned with net zero.

The Council's 2024 report notes that with geopolitics roiling gas markets and extreme weather hitting networks, more than half of the 127 countries it tracks slid backwards on at least one pillar last year, and resilience gaps are widening fastest in regions with rapid solar build-outs.

AI provides a unifying thread. By sharpening forecasts for solar, pre-dispatching storage, and nudging demand to follow renewable peaks, algorithms bolster security without costly fossil back-ups. Because those optimisations squeeze extra kilowatt-hours out of every panel, they also dampen wholesale price spikes, advancing the affordability/equity pillar. And every watt delivered from optimised renewables displaces a fossil watt, directly lifting the sustainability score.

The upside is enormous: the IEA's Electricity Mid-Year Update projects that soaring deployments of solar PV will push the renewable share of global generation to ≈35 % in 2025, overtaking coal for the first time in history, if grids can integrate that variable output. That 'if' is the challenge AI is uniquely positioned to solve.

A smarter energy future, powered by AI and IoT

As climate goals tighten, infrastructure ages, and power demands surge, AI offers something rare: scalability, speed, and tangible results. It is already proving itself across the value chain, from stabilising renewables and boosting efficiency to enabling grid independence through intelligent microgrids.

But technology alone will not get us there. Success now hinges on execution and urgency. Energy intensive industries must move beyond pilots and integrate AI into core operations. Regulators should accelerate digital-grid upgrades and incentivise data-sharing standards so that solar and storage assets 'speak' a common language.

Academia can help by opening weather and satellite data sets, further sharpening AI's predictive power. Finance, too, has a role to play: green banks and investors must fund the digital layer of energy transition with the same urgency as physical infrastructure.

The energy map is being redrawn in real time. Organisations that embrace AI as a foundational enabler will be best placed to deliver on climate commitments, maintain reliability and unlock new value streams. Scaling clean energy is no longer just a question of capacity, but of intelligence, and that is where the transition will be won.

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About the author

Edward Zhao is Global Vice President at Univers. With over 25 years of experience in the energy and technology sectors, Edward is a visionary leader dedicated to advancing sustainable innovation and driving the global transition to renewable energy.

About Univers

Univers is a global leader for AI in Energy.

Univers' EnOS™ platform empowers enterprises across industries to solve complex energy challenges with intelligent, data-driven insights.

With 365 million connected devices and 845GW of renewable energy managed, Univers is an AI-native company delivering end-to-end energy management solutions that support organizations across every stage of their energy transition journey.