Digital Transformation NETWORK

A Business Software Alliance Initiative

AI in Energy Utilities

Grids, Unlocked: How AI Makes Energy Transition Possible

Utility companies worldwide are at the center of a seismic shift. Electric, water, and gas grids are the foundations of modern cities; they face unprecedented demand from growing populations worldwide.

Getting energy and water to the right place at the right time is a staggeringly complicated task. Artificial intelligence (AI) is becoming an essential tool to optimize infrastructure, improve decision-making, and ensure that energy is delivered efficiently and securely to meet surging global demand.[1]

The use of coal, gas, and oil drove the first industrial revolution, powering a quantum leap in global development. However, a strong stance on energy security requires a variety of power sources. Unlike traditional energy sources, wind and solar are more variable, requiring real-time adjustments to balance supply and demand.

This report explores how AI makes a difference at every stage of the process:

SECTION 1

Generation: Whether turbines are turned by coal, gas, wind, or water, it all starts here. AI can help with every aspect, from predictive maintenance of machinery to powerful cyber defenses for nuclear systems.

SECTION 2

Distribution: With millions of miles of lines bringing electricity and gas to communities around the country, keeping the power on is essential. AI can help optimize flows in and out, connect sensors that report issues, combat leaks, and manage the landscape around power lines effectively.

SECTION 3

Consumption: Users have never had more power, in every sense of the word. AI gives them access to cheaper electricity through smart tariffs, lets them connect solar panels to add power to the grid, and optimizes EV charging.

AI enables this balancing act: it forecasts usage patterns, predicts weather shifts, and automates operational decisions that used to take hours or days. These capabilities are transforming how utilities manage generation, distribution, and consumption.

The importance of solar power has long been known. Back in 1885, Siemens's founder, Werner von Siemens, observed the photovoltaic effect, which turned sunlight into power. He wrote that:

> [T]he supply of solar energy[2] is both without limit and without cost, and…it will continue to pour down upon us for countless ages after all the coal deposits of the earth have been exhausted and forgotten.

Renewables, led by solar, are on course to meet almost half of global electricity demand by the end of this decade, a recent International Energy Agency (IEA) report says.[3] At the same time, the switch to electric vehicles (EVs) is rebalancing global oil demand, and geopolitical uncertainty threatens energy security, they note in the World Energy Outlook.[4]

Utility companies that embrace AI now can improve the outlook for consumers and businesses alike. For Cisco's 2024 State of Industrial Networking Report for Utilities,[5] the authors spoke to C-suite professionals from utilities in 17 countries. Half of respondents believe that AI will be the most impactful emerging technology in utilities industrial networking over the next five years.

This report explores how AI makes a difference at every stage of the process: **generation** of energy; **distribution** via grids; and **consumption**, where AI can do everything from helping smart buildings save energy, to optimizing EV charging. In each section, real-life examples from BSA members show how these technologies are improving our lives.

SECTION 1

Generating Energy: Basic Physics, Elevated by AI

Most power stations worldwide transform thermal energy, usually from burning coal or gas, into rotational energy, which is then transformed into electricity by a turbine. At every stage of this process, some heat is lost to the environment. AI can help minimize these losses by making processes more efficient, along with multiple other ways.

Hydroelectric power, where water pushes turbines to generate electricity, is one of the most well-established renewables. Janice Goodenough, CEO of Austria's HYDROGRID, notes that AI can massively enhance hydropower management. Optimizing turbine efficiency, especially for power plants with multiple parallel turbines, can lead to a 5–10 percent increase in power output,[6] given typical turbine efficiency patterns.

From assets that tell operators when they need maintenance, to speeding up admin in the ultra-secure environment required by nuclear operators, AI is proving an invaluable tool for the energy sector. Here are some ways it is bringing both light and heat to power generation.

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Microsoft

Big Wheel Keeps on Turning...

Germany's Bosch makes the world go round. Okay, not literally, but they build turbines found at the heart of everything from power stations to electrical systems in automotive factories. If turbines break down, everything stops, which wastes time, money, and resources.

To prevent such incidents, Bosch has developed an Integrated Asset Performance Management (IAPM) solution powered by a Digital Twin that runs on **Microsoft** Azure.[7] This solution lets rotating machines indicate when they need maintenance, helping them to run with optimal costs and maximum efficiency. These kinds of turbines often have an operational life of 10 to 20 years or more. By fine-tuning maintenance and servicing, AI saves huge disruptions at the source of electricity itself.

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AUTODESK

3D Thinking for Natural Gas

Massachusetts-based Process Pipeline Services is an engineering and consulting firm for the natural gas industry. It serves large natural gas distribution and transmission companies in the northeastern United States, with a primary focus on pipelines and above-ground facilities. In the face of changing parameters of the site and location, they have to make pipelines fit, see the clashes, and get the gas flowing.

They say **Autodesk**'s Plant 3D toolset[8] included in AutoCAD isn't just a "nice-to-have." It's an absolute must. From the very beginning of a project, 3D models help the company spot conflicts, manage constantly changing site plans, and reduce turnaround time in the piping design process. "Designing in 3D really separates our designs from our competitors," says Process Pipeline Services owner Mark Wood. "You can actually see where there might be conflicts—not just for constructability, but also for maintenance."

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SIEMENS

A Power Station That Tells Humans There's an Issue

AI has the potential to make autonomous power plants a reality. **Siemens** Energy has developed knowledge graphs, which are key to realizing this vision.[9] A knowledge graph is a special database capable of being evaluated by a machine. It shows the layout of power station components, as well as all the connections between them, including those that are nonfunctional. So, if there's an issue—or multiple, small, seemingly unconnected issues—the AI system can notice and tell humans, often before anything has gone wrong.

Siemens Energy now has an in-house database that brings together the data from 50 power station projects, with more than half a billion data points. The users report that, thanks to the integrated view of the data, they get answers to complex questions faster than ever—essential when they're keeping the lights on for everyone.

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IBM

Improving Efficiency of Nuclear Plants

Understanding data about the health and performance of nuclear power operational assets can predict when they require maintenance, and, ultimately, extend their life. Unfortunately, Canadian nuclear operator Bruce Power's heritage system for enterprise asset management lacked robust data-management capabilities.

They turned to **IBM** Watson services[10] integrated with Maximo to generate a wealth of insights about predictive maintenance and the root causes of equipment failure. "We're confident they will optimize our production of energy and medical isotopes," says Chief Information Officer Todd Warnell.

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Adobe

A Nuclear Code Green

Électricité de France (EDF) provides nuclear energy to millions of customers. The company's commitment to delivering clean-energy resources extends beyond its power plants into its offices. Division of Nuclear Power Plant Engineering, Deconstruction, and Environment (DIPDE), the office that deals with engineering and deconstruction of nuclear power plants, has adopted paperless processes throughout every stage of its operations, particularly in procurement, to reduce its carbon footprint.

DIPDE's Contractual Performance service adopted **Adobe** Acrobat Pro DC and Adobe Sign for document sharing.[11] Document exchanges are now managed electronically, and the company gets the orders it needs faster and more securely. Using Adobe Acrobat and Adobe Sign, EDF-DIPDE complies with ISO 25000 security standards, helping to ensure sensitive information from the procurement process is only shared with authorized persons.

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Steering Out of the (Wind) Shadows

Vestas Wind Systems, one of the largest wind turbine manufacturers in the world, has customers who use its turbines in 85 countries. AI helped them solve a longstanding issue: Wind turbines cast a wake, or a "shadow effect" that can slow other turbines downstream. Energy can be recaptured using wake steering, turning turbine rotors to point away from oncoming wind to deflect the wake, but it took AI to perfect this technique.

Working on a proof of concept with **Microsoft** and Microsoft partner minds.ai, Vestas[12] successfully used AI and high-performance computing to generate more energy from wind turbines by optimizing what is known as wake steering. Reinforcement learning is a type of machine learning in which AI agents can interact and learn from their environment in real time, and largely by trial and error. The results are a game-changer for wind power generation.

SECTION 2

Power Distribution: Using AI to Make Grids More Resilient

Grids, Unlocked: AI's Distribution Genius

AI makes management of power and water grids easier, more efficient, and more reliable. AI-driven grid monitoring and control systems analyze data in real time to help utilities identify and address potential issues before they happen. Predictive maintenance reduces disruptions to the power and water networks. And as more renewable energy sources come online, AI can help utilities manage the intermittent nature of these resources and meet the evolving demands of modern energy consumption.

New research from the IBM Institute for Business Value[13] reflects utilities' commitment to building a smarter grid. They surveyed nearly 600 global C-suite and senior utility executives about their grid modernization plans. They found that utilities are spending, on average, 9.8 percent of their annual revenue on grid modernization investments, which is more than 40 percent of their overall transmission and distribution investments. Further embracing grid modernization is critical to supporting the clean-energy transition and maintaining a reliable, affordable, and secure grid.

BSA members are helping energy and water companies across America and beyond to improve their distribution grids. From monitoring millions of sensors, to analyzing the billions of data points they produce, this work is perfect for AI.

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ORACLE

A Grid That Says Hi

Oracle Utilities Network Management System[14] helps utilities providers worldwide navigate the fast-evolving energy grid and rapidly expanding distributed energy resources (DERs).

New automated grid management and built-in AI will enable utilities to better orchestrate and control DER and grid-edge devices, boost network visibility with real-time insights, and provide a unified user experience across multiple platforms, according to Oracle.

One new feature in the latest version is Advanced Metering Infrastructure (AMI) Meter Pinging. It is not uncommon for field crews to restore power following an outage event, only to find that some customers are still without power. This latest release allows crews to ping AMI meters and quickly see if any downstream nested outages remain, avoiding return trips and increasing customer satisfaction.

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A Benchmark for Success

Improving grids by integrating AI is just one aspect of progress for utility companies. To assist utility companies on their journey to greener energy, **IBM** has created the Clean Electrification Maturity Model (CEMM)[15] in conjunction with the American Productivity & Quality Center. Based on 14 years of development and input from electric utility experts, the CEMM provides a series of benchmarks to help utility companies measure the maturity of their clean electrification capabilities, set priorities for transformation, and track their progress along the way.

The results from the first global CEMM benchmark of 90 transmission and distribution utilities paint a telling picture of the role that technology can play in this critical transformation. Companies that harness AI and data analytics can also make clean energy more viable overall by increasing their cost competitiveness over legacy energy sources.

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Keeping Leaves off the (Power) Line

Recent years have seen tragic wildfires across America, and the risk is increasing due to climate change, population growth, and habitation patterns. For electric utility companies, the unchecked growth of vegetation near power lines exacerbates the risk of wildfires. Most utility companies spend nearly 30 percent of their maintenance expenses on vegetation management programs.

Since forest cover is vital for the planet, the way forward lies in planned vegetation management. Infosys solution for Vegetation Management for Utilities[16] unlock the power of data to handle several tasks such as image surveys, risk assessments, and work management processes related to vegetation management. Thus, it helps utility companies take a risk prioritization-based approach, rather than traditional ones, to effectively manage vegetation—which keeps us all safer.

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Using AI to Fight Methane Emissions

Duke Energy, one of the largest US energy-holding companies, set ambitious goals to cut methane emissions to zero for its gas distribution business by 2030. It explored innovative new approaches to detect, monitor, and remediate emissions, such as using satellites and AI. However, it needed help to develop a rigorous, end-to-end approach to monitor emissions and lay the foundation for predictive maintenance.

Duke Energy brought in Accenture, Avanade—a joint venture between Accenture and Microsoft—and **Microsoft**[17] to co-innovate a pioneering solution that would help meet its ambitions and potentially advance industry and regulatory standards. The result is a first-of-its-kind, Azure-based cloud platform that monitors baseline methane emissions at every stage of distribution including pipelines and gas meters. The solution quantifies and prioritizes findings in graphic dashboards, making data easily consumable at multiple levels of the organization.

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Better Data for a Smart Edge

In Canada, renewables power about 20 percent of the country's primary energy supply—and consumer demand for renewable energy is rising fast. Énergir, a regulated diversified energy utility company based in Québec, is aiming to be carbon neutral by 2050. To achieve this, it aims to step up its energy efficiency efforts, accelerate the distribution of renewable natural gas in its network, and develop a strong complementarity between the gas and electricity networks. To enable business model transformation, the utility needed to renew its infrastructure and standardize its business operations and support functions.

S/4HANA® proves its value every day.[18] Énergir's analysts no longer input data manually and instead spend more time analyzing the performance of renewable energy sources. Customer service issues are resolved in record time, too, thanks to improved machine learning and data efficiencies. What's more, monthly financial reporting time has been reduced by almost a third and Énergir can better monitor and evaluate its Environmental, Social, and Governance (ESG) impact. The larger outcome: This project lays the foundation needed to accelerate the transformation of Énergir's business model and enable it to achieve its 2030–2050 Vision.

SECTION 3

Power Consumption: What AI Can Do for Consumers

Being a utility customer used to just mean paying your bills and plugging in your appliances. Now, it's much more: the relationship between companies and end users has been transformed. Homeowners who install solar panels on their roof are producers *and* consumers. EV use is revolutionizing demand. Furthermore, data analysis and AI mean power outages are less frequent, and when they happen, customers are better informed.

Smart meters in homes can analyze customer data and preferences, generating personalized recommendations for energy usage and savings. AI-powered chatbots and virtual assistants also provide 24/7 customer support, resolving queries efficiently and reducing the burden on human customer service representatives.

Commercial buildings account for a significant share of global energy consumption, yet they are often places where significant amounts of energy are wasted. Now, as data on building energy use has increased, a wide variety of information is available to optimize smart systems so they deliver energy services exactly when they are needed.

Although critical for the clean-energy transition, EVs pose a real challenge for the grid.[19] John Taggart, cofounder and Chief Technology Officer of WeaveGrid, says EV adoption adds significant energy demand. "The last time they [utility companies] had to handle this kind of growth was

when air conditioners first took off," he told MIT Technology Review. San Francisco–based WeaveGrid collaborates with utility companies, automakers, and charging companies to identify optimal charging times and notify customers they should charge their vehicles. This turns the cars themselves into a valuable source of energy storage.

Finally, DERs are small-scale energy systems that power a nearby location, such as rooftop solar panels of a back yard wind turbine. DER can be connected to electric grids, making these customers producers as well. This fundamental remodeling of the relationship between consumer and utility can be kept fair thanks to AI.

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Red Flags, Detected

IBM's anomaly detection solution[20] for energy and utilities enables companies to be aware of abnormal energy consumptions. For each entity of the system (it can be a smart meter, current clamp, or other device able to monitor energy consumption), the system will train a specific AI-based anomaly detection model that will detect abnormal patterns.

Leading companies around the world are now committed to validating measured ESG reporting and nonfinancial performance disclosures. In this context, identifying abnormal consumptions is the first important step that leads to consumption awareness, enabling utilities to make better decisions.

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Cheaper Power by Avoiding Surges

Québec, Canada's second-largest province, has long, harsh winters. Combined with the ongoing transition to electricity in transport and heavy industry, the strain on its electrical grid called for new ways to produce and preserve energy. Hilo therefore now offers affordable smart home solutions, which use Internet of Things (IoT) devices like smart thermostats, water heaters, electric vehicle charging points, and others to optimize energy use.

In 2019, the company turned to **Microsoft**, who helped them optimize[21] energy use by predicting demand at peak times with Azure Data Explorer. Thanks to continuous insights from millions of telemetry points, they can predict short-term demand spikes, proactively managing power consumption to help Quebecers consume less energy and pay less.

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Informatica

Better Data for a Smart Edge

Genesis Energy is one of New Zealand's largest energy companies, supplying nearly 500,000 customers with electricity, natural gas, and liquefied petroleum gas (LPG). They wanted centralized and trustworthy data to give them a competitive edge[22] in the era of AI.

For example, inaccuracies in customer data—such as incorrect postal addresses and pricing information—had previously slowed down operational and compliance workflows. Using **Informatica** CDQ scorecards and exception reports, the Genesis customer operations team was able to save thousands of dollars in monthly operating costs and reduce pricing compliance risk.

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salesforce

Building Loyalty With an AI Advantage

Formerly known as British Petroleum, bp is a global company that delivers energy products and services to customers around the world. They wanted to improve customer service (and agent) experiences by giving people instant access to a chatbot, which can then be dealt with by an agent.

They partnered with **Salesforce**[23] to create AI-generated Work Summaries that help agents get up to speed for faster service. Einstein 1 Service will create a succinct synopsis of the bot conversations. Agents won't have to sift through chats, phone records, or emails to understand the customer's needs. Instead, a short summary will relay the important details needed to confidently kick off the conversation.

Conclusion

From turning coal into electricity, to deciding when to do the ironing, AI can play a role in making energy flows cheaper and more efficient. Using billions of data points to optimize when and how energy flows in and out of the grid has been transformational for energy security. With AI, companies can flag abnormal activity and check it out, customers can get power when it is cheapest with variable tariffs, and proactive management of power networks helps counter the risk of fires.

American technology companies are helping utility providers worldwide get energy to their customers quickly, efficiently, and above all, safely. AI can help enhance every step of this process.

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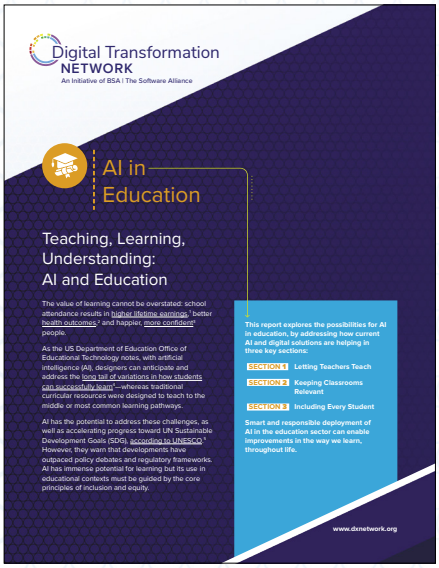

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