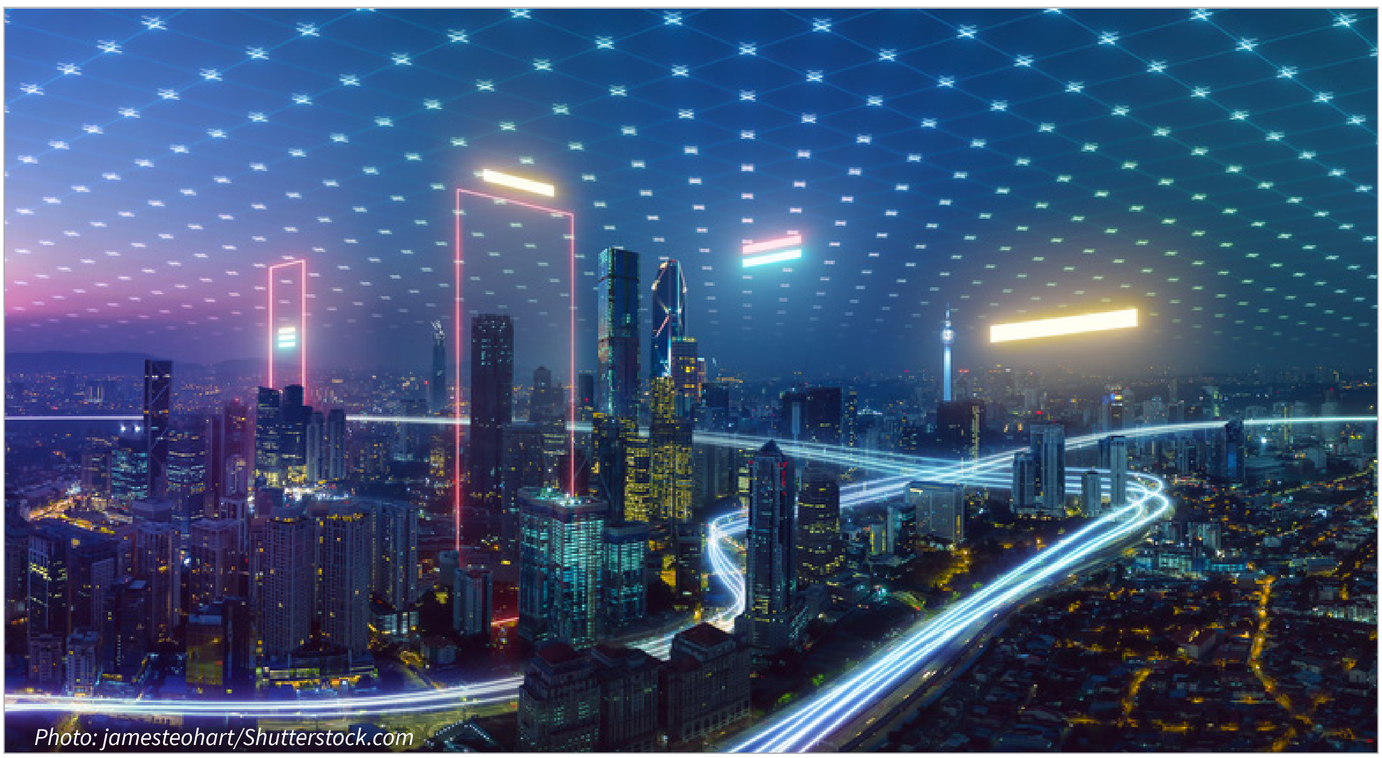
MICROGRID KNOWLEDGE SPECIAL REPORT

The AI Microgrid

How AI Makes Microgrids More Predictable, Cost Effective and Resilient



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Overview

In this paper, we describe the merits of artificial intelligence (AI) to predict, model, simulate, optimize and autonomously control microgrids.

Not only must sophisticated microgrids provide reliable power, optimize load and capture market opportunities, but they also now need to balance the variability of renewables.

We seek to educate independent power producers, microgrid developers and operators, system integrators, asset managers and owners about new AI solutions now available. These solutions are particularly important given the complexity of today's microgrids as they increasingly incorporate intermittent renewable energy. Not only must sophisticated microgrids provide reliable power, optimize load and capture market opportunities, but they also now need to balance the variability of renewables.

How can they do all this smarter and faster?

Microgrids must find a way to predict the unpredictable.
AI is the answer.

The Brave New World of Microgrids

Microgrids are front and center in the transformation from traditional grid models to decentralized energy. Transformation is driven by the Four Ds: decarbonization, decentralization, democratization and digitization. Together, the Four Ds set the world's energy stage for more autonomous and independent energy production and management.

Power consumers increasingly rely on microgrids for greater energy reliability, cost savings and to reduce carbon emissions. Microgrids act as decentralized power resources that can island away from the central grid when necessary, such as during a power outage, and deliver power to their host from on-site energy sources. These software-driven systems are engineered with digital controls, automation and platforms to manage and optimize energy production, consumption, equipment and life cycle management.

Microgrids manage not only their internal energy resources, but also their relationship with the central electric grid. Constantly seeking an optimal resource mix — based on energy prices, sustainability, reliability or whatever goals the microgrid operator establishes — they at times rely on their internal generators and energy storage systems and at other times turn to the grid for energy. Microgrids also come to the aid of the grid when it is under strain, contributing energy and services and receiving revenue in return. The grid may need these services when it is in danger of demand exceeding supply, such as when wind and solar resources suddenly stop performing.

So, planning and managing microgrids can be complex because they operate within a landscape of variability and change.

Microgrids:

- Constantly seek out the optimal mix of resources, which changes based on fuel availability, pricing, emissions and other factors.
- Navigate dynamic energy markets, which pose price opportunities and challenges.
- Balance sometimes unpredictable energy demand and intermittent forms of renewable supply, both within their own footprint and on the grid.

AI can be applied in the planning, deployment and operation phases of a microgrid, to benefit microgrid developers, equipment providers and integrators, and operators.

For microgrid developers, AI offers swift capacity planning via real-time modeling of a massive amount of data, helping them make decisions about grid equipment, solar and wind configurations, and use of electric vehicle charging infrastructure.

For equipment providers, AI provides modeling for efficient use and longevity of controllers, solar inverters, battery systems and other distributed energy grid resources.

For microgrid operators, AI removes the need for grid operators and asset managers to intervene in microgrid operations. Instead, energy is automatically delivered at the right price, place and time — without human actors making any decisions or pulling any levers.

What exactly Is Artificial Intelligence?

Artificial intelligence (AI) is the ability of a "machine" — via computing iterations and algorithms — to perform cognitive functions ordinarily associated with the biological human mind. Cognitive human actions such as reason, perception, deduction, problem solving and others, are performed using data and computing.

Using a machine (a computer), AI can solve problems, learn patterns and iterations, and draw inferences that would otherwise be cumbersome for a human mind to accurately compute. AI allows machines to process huge volumes of data and "learn" patterns from such data to accurately draw inferences that would otherwise be impossible for human minds to process.

AI enables many different solutions for automation, robotics and efficient production in a range of industries, including in the design and operation of microgrids and their supporting technologies. Microgrids can employ artificial intelligence to make energy management decisions with more autonomy, speed and precision.

What Is Machine Learning?

Machine learning is the process by which a machine (a high-performance computer, for example) applies specific algorithms to process data and then detects and identifies patterns from that data to draw inferences, predict outcomes and make recommendations that ultimately drive decisions.

Thus, a machine "learns" from data and, through such learning, offers intelligence. Most recent advances in AI have been achieved by applying machine learning to very large data sets in many industries, including energy production. Machine learning algorithms also continuously process new data to improve accuracy and efficiency over time.with lower or no emissions fuel sources as they emerge.

Unmatched Energy Orchestration Across Grid Devices

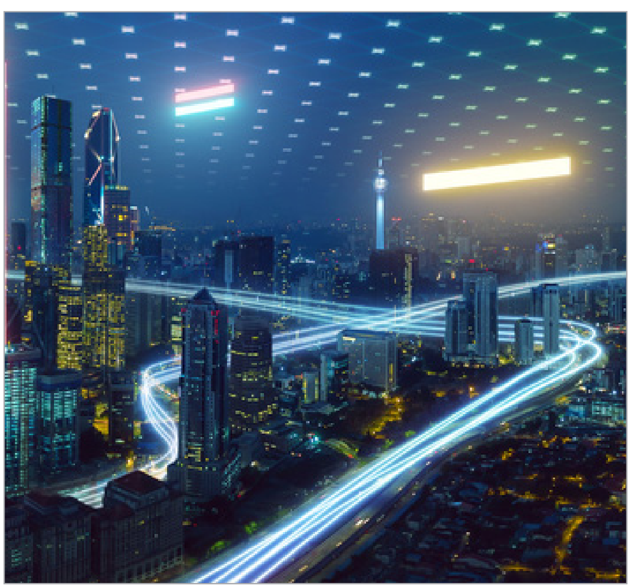
Centralized power grids are dynamic and complex, and they encompass voluminous and sometimes complicated data. The introduction of smart meters has significantly increased the amount of data, by as much as 54 petabytes annually, according to some estimates.

In advanced economies, like the US, microgrids are typically connected to the central grid and function in parallel with it. As information and conditions change on the central grid, an advanced microgrid may adjust its operating pattern in response. The human mind cannot keep up with the speed or volume of the data, therefore it cannot maximize the capability of the microgrid. That's where AI and machine learning come into play.

AI can handle the massive data volumes required to continuously monitor the state of energy generation and storage devices on both the grid and the microgrid. It may also process other data such as energy demand, weather patterns, transmission flow and energy price volatility.

Continuous and real-time modeling of such a huge volume of data enables AI to compute and deliver efficient solutions swiftly. Microgrid operators can always capture energy demand signals and deliver service precisely, at any time, present or future.

When artificial intelligence and machine learning manage the planning, deployment and continuous operation of the microgrid, the system achieves efficient orchestration of all inputs and outputs.



Use of AI modeling benefits a range of stakeholders in the microgrid space, including:

- utilities
- independent power producers (IPPs)
- microgrid developers and operators

It also benefits equipment providers by enabling them to:

- efficiently use controllers
- accurately specify solar inverters, battery systems and other equipment for their customers

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These AI models can seamlessly integrate with existing systems used by utilities (SCADA, ADMS, AMI, DERMS and others). No data science experience is typically required to use the software that deploys AI models.

It may be used from a remote platform such as a:

- central control location
- substation
- data center

AI can also be utilized via edge computing, localized to an operation to provide device control and achieve edge inferencing as well as in real-time synchronization of multiple grid edge devices. These models, through precise modeling and optimization, render a holistic view of the plant state and capacity.

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Putting AI To Work for Effective Energy Management in the Real World

Planning the construction of a microgrid for a cryptocurrency mining data center

The use of AI and machine learning can be seen in a case where Veritone, an AI solutions provider for the energy market, was tasked with helping plan a microgrid for a cryptocurrency mining data center. The microgrid uses solar panels and battery storage, as well as wind power, hydrogen fuel cells and natural gas.

The AI model incorporated weather data inputs, including wind speed, temperature and solar irradiation, and the power input from the various generation and energy storage resources. The energy load and demand were accurately forecasted using AI models. This provided planners with information about how much capacity to deploy: how many solar panels, wind turbines, battery banks, etc.

To build the AI model and ascertain what assets were needed, Veritone took four key steps:

- **Simulated assets separately:** Assets were first simulated individually, not in interoperation with other assets.
- **Simulated the system:** Assets were then simulated in concert with other assets acting together.
- **Built out the system:** Once the assets were simulated — individually and as a system—the microgrid can be deployed.
- **Expanded the system:** Based on actual demand and anticipated demand, the system will be expanded according to need.

In the case of the cryptocurrency data mining center, Veritone utilized Monte Carlo simulation models, coupled with a risk-minimizing Veritone optimizer tool, to determine optimal energy mix. Veritone considered the number, type and size of solar panels, wind turbines and battery storage systems, and the dynamic price of these energy sources. The models process millions of data points in real time. For example, they may use data from weather forecasts, load profiles and energy pricing. They may also compute data extracted from energy device specifications including warranty information, optimal energy storage levels, dissipation levels, temperature limits, humidity limitations, and other device and environmental factors.

AI modeling and optimization improves microgrid operations in many ways:

- **Manual vs. autonomous:** Determines what operations, control and equipment should be manual and what should be automated and autonomous.
- **Distributed and stored power:** Provides details and recommendations as to how generated power should be distributed and stored based on production and demand.
- **Renewable variability:** Manages the power generation variability — particularly renewable energy, which produces intermittent power based on changing weather.
- **Enhanced forecasting:** Accurately forecasts energy supply and demand, as well as pricing where applicable.
- **Energy costs:** Can reduce overall energy costs as well as the total cost of ownership.
- **Resiliency:** Enhances the ability of microgrids to provide resilient power in an environment of change and uncertainty.

Improving building efficiency for US GSA

By employing device control based on predictive energy demand, the General Services Administration (GSA) was able to optimize energy consumption and reduce costs.

The GSA manages buildings for federal agencies throughout the federal government. It seeks to reduce energy consumption and overall energy costs for buildings. The GSA set out to optimize the utilization of heat and the operation of chillers within its buildings. Both the heating and chiller systems have controllable setpoints that can be automated with controllers. Controllers can autonomously adjust settings to meet energy demand and act on voltage sags, swells and transients.

By applying artificial intelligence and modeling, operations were optimized. This resulted in more efficient chiller and heat operations, which minimized peak demand charges from electric utilities.

The result: When optimal controller settings were applied, the GSA buildings consumed less energy. They also reduced overall energy costs and improved their Energy Star ratings.

Extending battery longevity in PJM

An energy storage services provider in the Pennsylvania, New Jersey and Maryland (PJM) market uses a network of Li-ion batteries to provide customers with optimal storage capacity.

The life cycle of a Li-ion battery can be improved by managing where and when batteries should charge or discharge. Using AI modeling and optimization and applying available data, controllers can make necessary adjustments to the energy storage system to ensure this happens.

In this situation, AI helped actuate volt-amps reactive and frequency controls. The system was able to accurately forecast demand response events, reducing the use of Li-ion batteries.

The result: The energy storage services provider was able to maximize ancillary services revenue in the PJM market. The addition of AI helped improve battery performance, health and longevity.

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About Veritone

Veritone is a leader in enterprise artificial intelligence solutions, accelerating the world's transition to more sustainable, reliable and affordable energy. Its customers include utilities, independent power producers, and microgrid developers and operators who use Veritone's software to optimize, synchronize and intelligently control macro- and microgrids.

Veritone Energy Solutions uses patented AI technology and the Veritone aiWARE operating system for AI to make clean energy more predictable, cost effective and resilient, accelerating the mission to end global dependence on fossil fuels. Veritone's patented, real-time dynamic modeling and predictive device control enables autonomous microgrid management, optimizing smart grid energy distribution by continuously knowing how much energy to deliver from which asset. This groundbreaking technology ensures consistent, cost-effective clean energy during normal operations and grid resilience in the face of the unexpected.

The role of cooperative distributive inferencing in AI-optimized microgrids

The heart of Veritone's Energy Solutions is its unique, patented cooperative distributive inferencing (CDI) technology. This technology is used for real-time predictive microgrid modeling and learning, providing intelligent, autonomous control of microgrid assets. The technology incorporates three components, working in concert to optimize microgrid control:

1. **Forecaster** uses current weather data, load data and price data to predict device state and send those predictions to the user.
2. **Optimizer** uses domain rules and sensor data to produce the optimal dispatch model and state for the device under control at any given time.
3. **Controller** applies directions from the optimizer to perform centralized optimal device control through the IPP/developer, or autonomous optimal device control, at the edge device. The device state is sent back to the controller.

The heart of Veritone's Energy Solutions is its unique, patented cooperative distributive inferencing (CDI) technology. This technology is used for real-time predictive microgrid modeling and learning, providing intelligent, autonomous control of microgrid assets.

The optimizer uses device state feedback to continuously machine learn and update the dispatch model for the controlled device to ensure always-optimal power.

Veritone's technology works in concert with existing utility and microgrid energy management systems to provide optimal energy outcomes.

Contact Veritone to discuss your microgrid optimization and resilience challenges:
www.veritone.com/energy