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APRIL 2021

How AI Forecasting Can Help Utility Regulators Weather the COVID-19 Storm

Siddhartha Sachdeva

The coronavirus pandemic is transforming energy consumption. During the recent COVID-19 lockdowns, commercial energy usage slumped 30 percent, whereas residential demand shot up during the day. These changes bring challenges to both utilities and regulators. As utilities manage the changing energy landscape, regulators need new tools to understand our energy markets, the economic transformations taking place, and the industry's long-term prospects.

One solution that can add important new insights is a subfield of Artificial Intelligence (AI) called machine learning (ML) enabled predictive intelligence. Smart meters and other smart-grid infrastructure generate vast amounts of data, but unlocking insights from these huge and interconnected data sets can be challenging. That is where ML-enabled predictive intelligence shines. By using breakthrough machine learning tools to identify patterns in large data sets, it's becoming far easier to identify actionable signals amidst the noise.

For example, load clustering analysis can be used to group customers according to similar usage patterns. These tools help create customer segments that make it easier to assign these users to appropriate rate classes. Another approach might use load disaggregation to differentiate between customers based on their sensitivity to weather, with an ML-enabled model learning customer usage trends and predicting consumption patterns with respect to the changes in weather, daily routine, or device usage. Most powerfully of all, AI tools can harness these signals to anticipate and forecast future demand patterns with far greater accuracy than current historical analysis tools, enabling providers and regulators to understand the changing energy environment and create more effective strategies.

This Insights paper examines the ways that ML-enabled predictive intelligence can shield utilities from financial and operational disruption, lowering costs for customers, while giving regulators a rich new source of intelligence as they work to protect customers and steer the sector toward calmer waters.

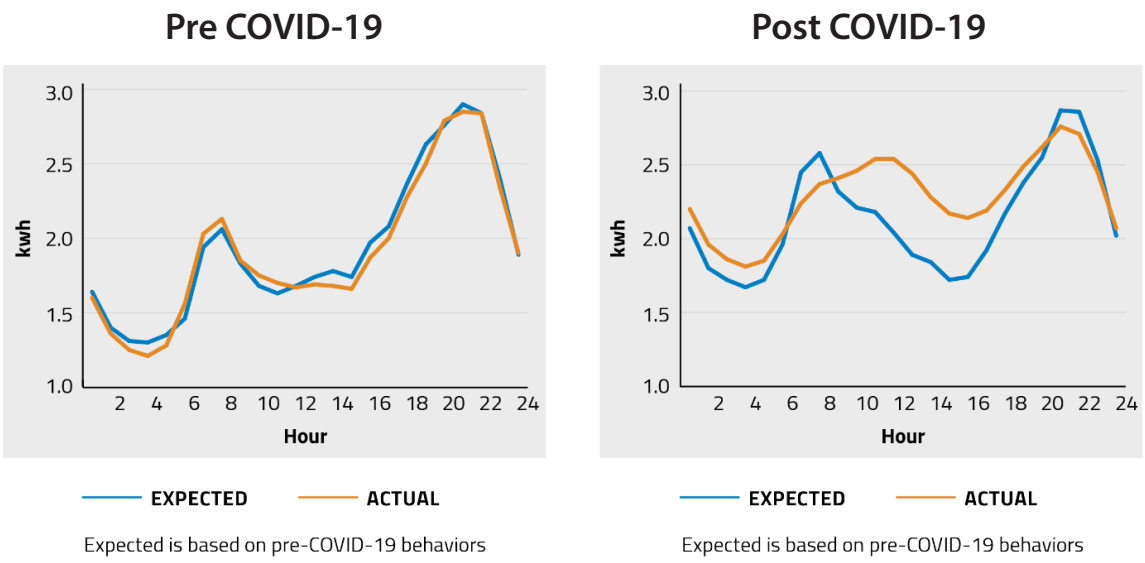
Case Study: What AI Reveals about Post-COVID Energy Demand

To illustrate the power of ML-enabled predictive intelligence, Innowatts used its AI models to examine the way that power requirements changed during the early weeks of the COVID-19 pandemic. Within three days of March's shelter-in-place orders, Innowatts' ML based models — based on readings from more than 40 million meters processing 4.83 billion data points per hour — spotted new patterns and developed accurate predictions to account for the shift in commercial and residential energy use due to the pandemic.

As shown in **Figure 1,** we found that residential consumption was between 6-9 percent **higher** than normal, and up to **15 percent higher** during working hours. Load patterns also changed: mealtimes became optional, with lunch and dinner peaks evaporating as home-bound families cooked at whatever time suited them best.

Today, the U.S. economy has rebounded from the worst of the downturn, and AI forecasts have helped us see exactly which parts of the economy are doing well, and which are still struggling. For example, consumption is trending up for some segments, including social services, convenience stores, gas stations, and grocery stores, while power consumption remains low among business associations, banks, restaurants, furniture stores, and fitness centers.

Figure 1: Based on ERCOT load, pre- and post- lockdown.



Interestingly, the resurgence of commercial demand in recent weeks has not led to a corresponding downturn in residential demand. In fact, we are still seeing a seven percent increase in residential load during the standard workday, likely due to remote schooling and working, as well as lower headcount as some businesses have closed or contracted.

How Utilities and Regulators Can Leverage AI-enabled Energy Intelligence

Energy forecasting typically looks to past consumption to understand future usage, using mathematical models to connect historic usage patterns and current data describing weather patterns, market conditions, and other inputs.

AI forecasting is different. Instead of just relying on aggregated historical trends, ML-enabled predictive intelligence can glean data from millions of individual smart meters to create a rich library of demand scenarios for different events and technologies, reflecting the reality of how and when electricity is used in the real world. This library is built over time according to specific needs and circumstances: for instance, in an area with heavy EV or solar penetration, the ML-enabled system can create footprints for the classes of customers found in the area, and use those footprints to generate customized forecasts. Using advances in machine learning, the data library is translated into actionable intelligence, such as predicting high-usage and bill shocks, or generating maintenance alerts for malfunctioning AC and heating systems, and forecasts that outperform conventional tools.

Compared to conventional forecasting methods, the results are remarkable. For example, AI-based forecasts recently outperformed all other prediction models in a year-long EPRI study, as shown in **Figure 2.**

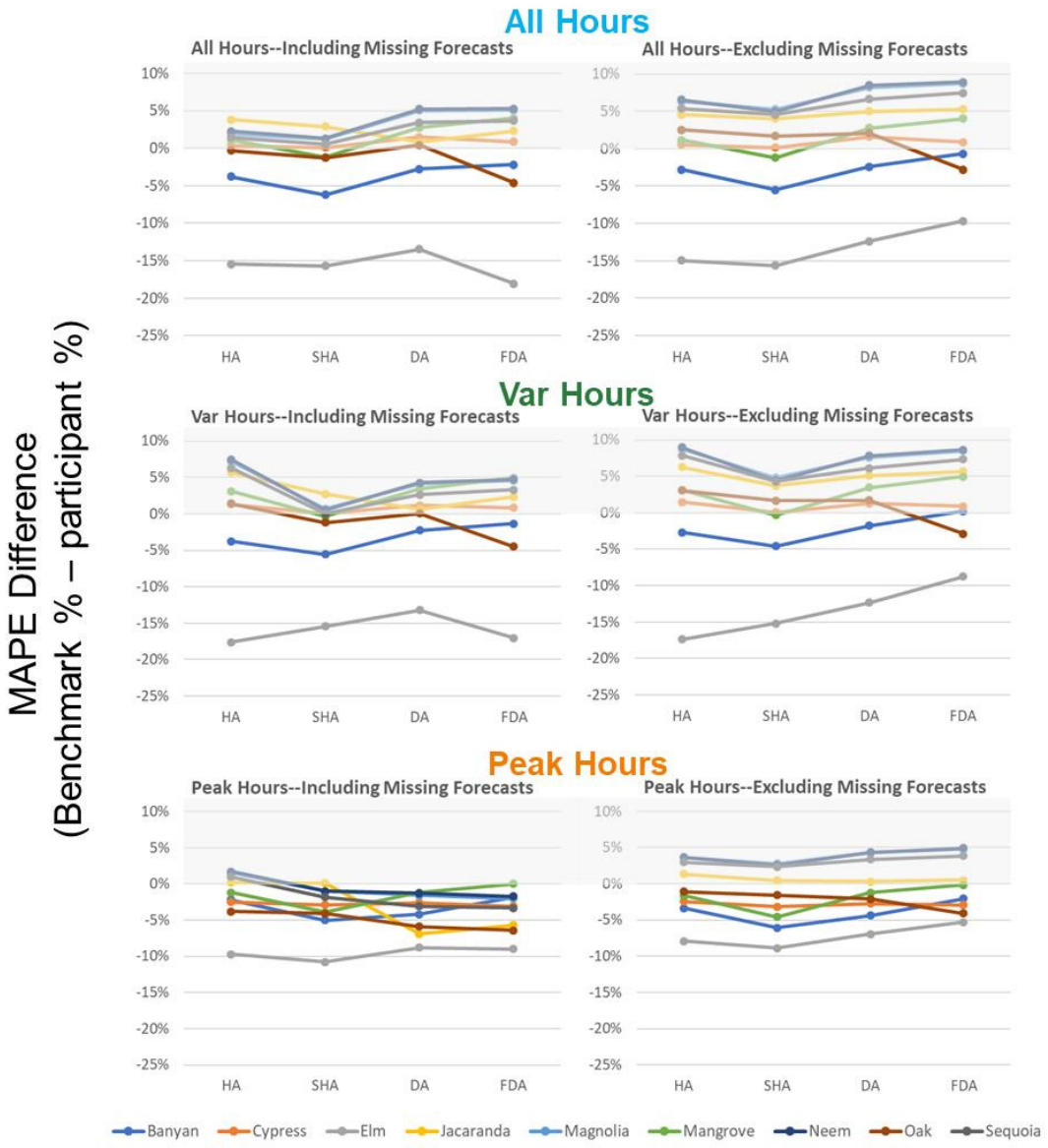
Such forecasts also outperformed ERCOT's own forecasts during last summer's Texas heatwave, with a mean absolute percentage error (MAPE) of just 1.5 percent, compared to more than 2 percent for ERCOT's own forecast, illustrating the potential of AI-powered forecasting to help both utilities and regulators understand changing conditions.[1]

The recent freeze event (Feb 13-Feb 19) in Texas further underscored the importance of AI-powered forecasting

1 AIT News Desk, "Innowatts Day-Ahead Load Forecast Outperforms ERCOT During Late Summer Heatwave, October 19, 2021," https://aithority.com/machine-learning/innowatts-day-ahead-load-forecast-outperforms-ercot-during-late-summer-heatwave/.

Figure 2:

Note that each participating model was assigned an anonymous ID. Innowatts' models in this report are referred to as Magnolia, Neem, and Sequoia.



models. The following table provides a performance comparison:

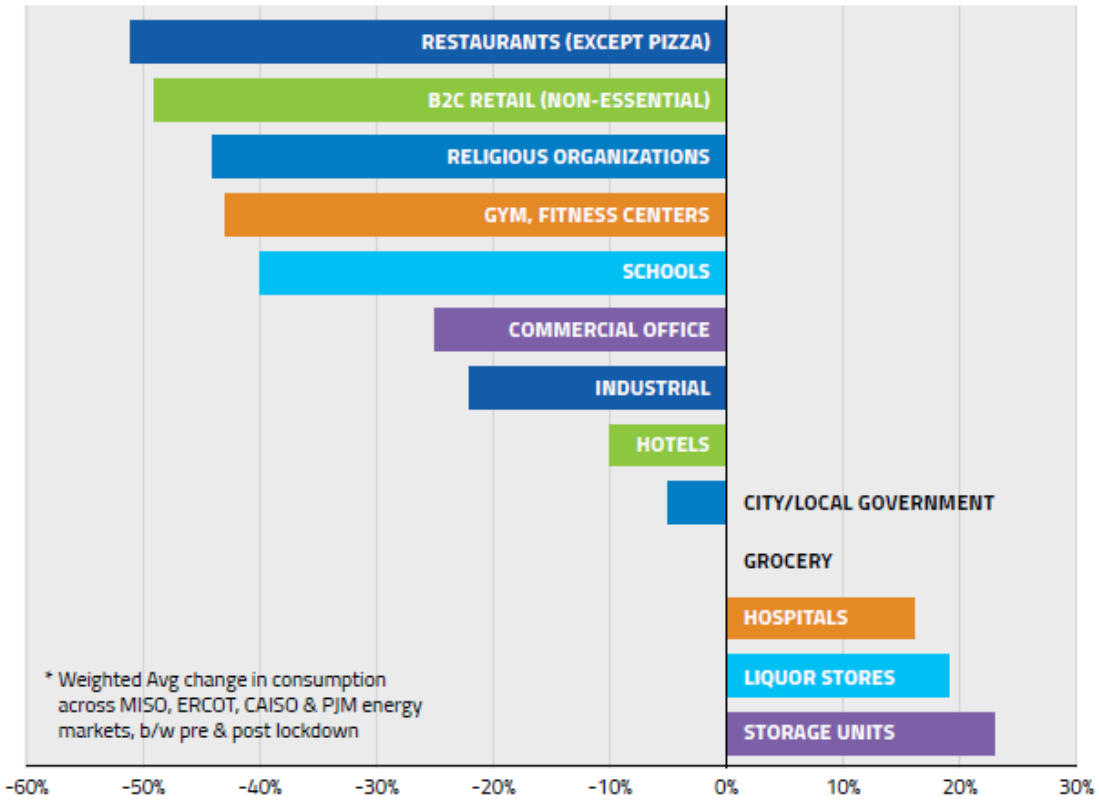
	FORECAST ERROR (%)	
ERCOT Congestion Zones	Traditional Forecasting Models	AI-Enabled Forecasting
HOUSTON	38.9%	9.4%
NORTH	31.9%	10.8%
SOUTH	36.7%	9.7%
WEST	24.4%	10.1%

In most cases, traditional models do not quantify the sensitivity to extreme weather at a granular level and hence are not able to provide the right demand signals to the grid operator and generators. For this reason, customer-centric AI-enabled models and forecasts lead to three key benefits for energy regulators:

1) **Better aggregate predictive accuracy.**

As the ERCOT and EPRI studies show, energy providers get more accurate total load forecasts

Figure 3



when using ML-enabled predictive intelligence tools. That delivers direct and tangible benefits in areas that matter to regulators. First, companies can improve accuracy of revenue and rate case forecasts by at least 5-10 percent, including bounce back scenarios. Second, companies can generate more accurate cash flow forecasts, which directly impact providers' capital needs, working capital, bond ratings, and overall financial stability.[2]

2) **Insights into load and revenue shifts by customer groups.**

Many commissions are considering how to deliver assistance to sectors hard hit by the current economic turmoil, while ensuring that resources are not directed to sectors that do not need it. This is precisely the kind of data that can be generated using smart-meter data and ML-based analytics. As described earlier, ML-enabled analysis of data showed big shifts in specific industries when the COVID-19 lockdown started **(Figure 3),** including:

- Restaurant energy usage fell **51 percent,** whereas food delivery services thrived. Indeed, pizza delivery services have used **20 percent more energy** since the crisis began.

- Consumer retail stores (such as department and specialty stores) almost halved their energy

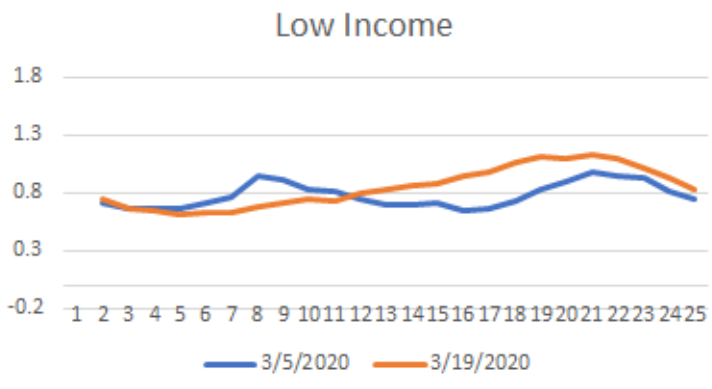
2 Siddhartha Sachdeva, "From the Big Short to the Big Freeze: Undifferentiated Data Woes," February 25, 2021, https://www.innowatts.com/insights/demand-analytics-big-short-big-freeze/

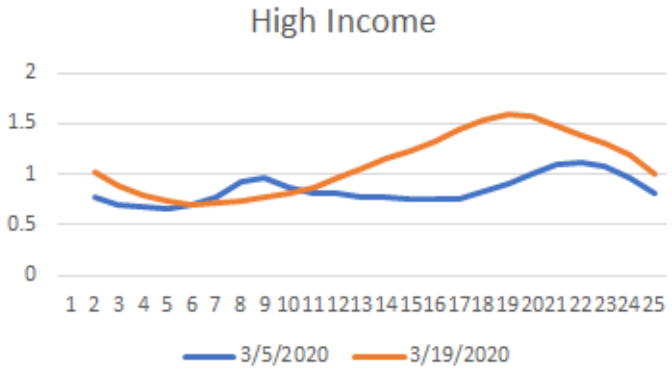
use, while other categories continued to do well. Liquor stores, for example, increased their usage by **19 percent.**

3) **Ensuring equity for all customers.**

By using ML-enabled predictive intelligence and smart meter connectivity, sector-specific and local data can help regulators to better understand impacts on individual neighborhoods. The data gathered and processed with ML-enabled predictive intelligence show that energy use shifts were more pronounced among high-income customers — a reminder that low-income workers were often out on the front lines, even as higher earners shifted to remote work. Such insights can help regulators ensure that energy rates and access are equivalent across the provider's footprint and not based on neighborhood composition, income level, and similar factors. **(Figure 4)**

Figure 4: Changes in energy load in the ERCOT region based on income level.





ML-enabled predictive intelligence, using historic data to develop ML-based models, isn't just useful for regulators. It can also help utilities generate more accurate load forecasts. Extracting sector-by-sector demand data from meter-driven analytics adds a new layer of market intelligence, helping utilities plan for and overcome new challenges, while ensuring that the benefits of efficient, intelligent forecasting flow to consumers in the form of reduced costs.

There are four key areas where bottoms-up AI-enabled energy intelligence and forecasting can help utilities and regulators during these challenging times:

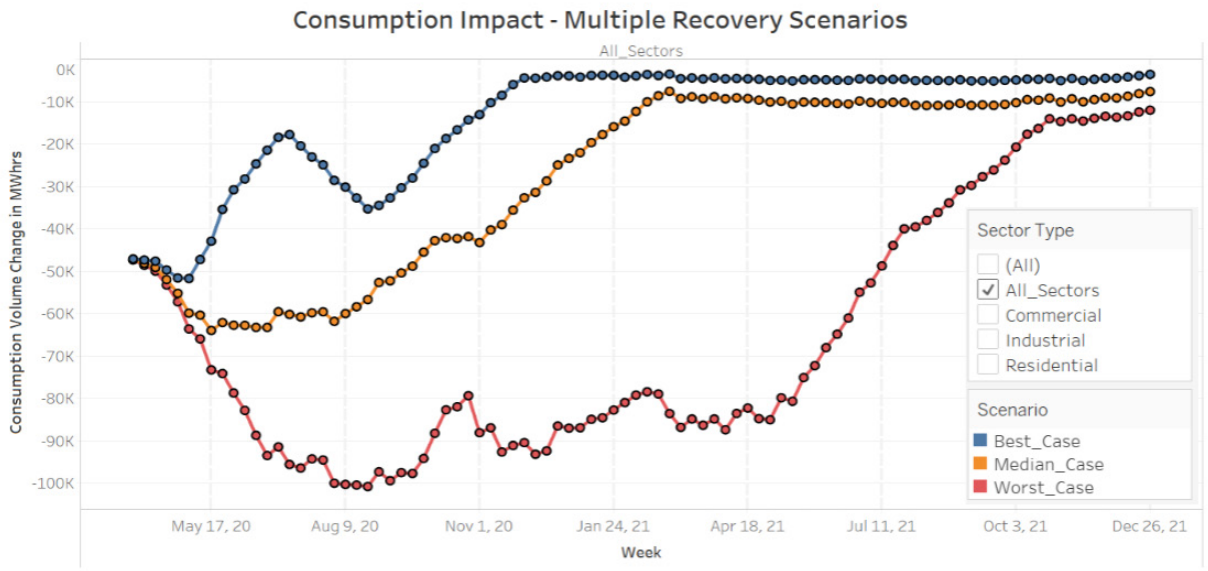
1) **Scenario testing and go-forward recommendations.**

Utilities urgently need accurate short and mid-term demand forecasts across their full range of rate classes and industries served. By accurately modeling the transformations taking place in connection with both changes in local conditions and the impact of the focus of prosumers on managing their energy usage, utilities may anticipate future scenarios. By encouraging utilities to adopt AI analytics, regulators may help electricity providers operate more efficiently, plan more effectively for the future, and collect clearer data to illustrate the pressures they're facing during the coronavirus crisis. **(Figure 5)**

2) **Better revenue / earnings forecasts.**

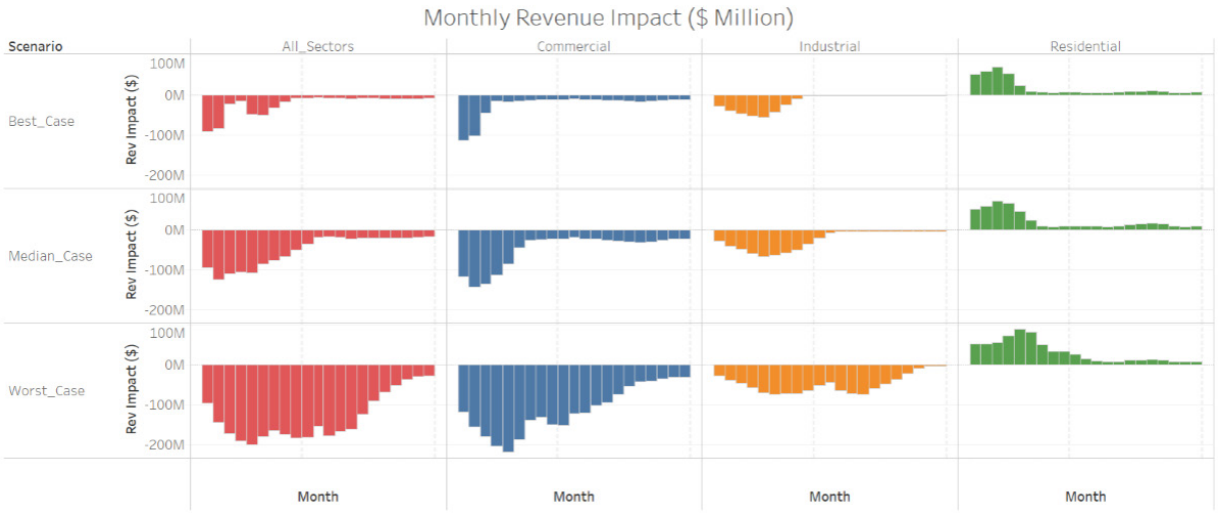
During periods of disruption, forecasts based on historical data are unreliable, since usage patterns no longer correspond to the data on which the

Figure 5: Examples of various recovery scenarios representative of the ERCOT region.



models were based. The ebb and flow of shelter-in-place orders and re-openings makes it challenging for utilities to anticipate demand and avoid volatility — especially since bankruptcies and changes in consumer behavior mean some demand is unlikely to return. AI forecasting offers intelligence based on actual demand, with faster learning capabilities letting utilities quickly adapt to both short-term disruptions and enduring changes in energy usage. **(Figure 6)**

Figure 6: Examples of various recovery revenue scenarios representative of the ERCOT region.



3) **Cash flow management.**

With payments from commercial accounts down and residential disconnections suspended, utilities could face major cash-flow problems. Understanding the shift in usage is essential, as utilities seek to live up to existing financial commitments and determine their ability to fund planned and existing capital projects. Capital investments and maintenance projects can also be adapted to new conditions, with more accurate and responsive ML-enabled modeling allowing decisionmakers to account for current and expected changes in demand patterns.

4) **Expedited rate case filings.**

Financial instability is sparking calls for rate increases. Understanding how energy use is changing and the drivers behind that change is essential, as utilities seek to justify passing costs along to customers. Documenting energy usage through AI forecasting helps utilities and regulators to create transparent, evidence-led policies and win broader support for rate increases. While optimizing rates will always require human judgment, richer and more up-to-date ML-enabled data and forecasts give regulators and utilities powerful new tools to enable better decision-making.

Conclusion

AI-driven load forecasting is part of a broader shift toward data-driven, technologically advanced, and customer-centric power management. Generation systems, the grid itself, and all other forms of energy infrastructure are getting smarter and more interconnected. Providers that capitalize on intelligence-led digital transformation will be able to put customers first, not only by anticipating changes, but by driving them, and proactively managing costs, revenues, and customer satisfaction. Regulators may consider engaging with providers to understand and help manage this transformation.

When electric utilities seek assistance, regulators may wish to inform them about the potential for AI tools to assist in providing accurate forecasting.

About the Author

Siddhartha Sachdeva is the founder and CEO of Innowatts, a software platform that combines energy data and predictive analytics to enable utilities to increase customer value, unlock grid edge opportunities, and accelerate energy transition. Prior to founding the company in 2013, Siddhartha served as the Senior Director of Innovation and Technology at NRG Energy. He has more than 20 years of experience in power and utilities.

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