WHITE PAPER

Analytics and the Modern Energy Supplier

How IoT and AI make digital utility transformation possible

Contents

Disruptions in the energy supply chain continue to challenge the viability of traditional utility business models. For example, some utilities with declining load growths – due to distributed energy resources and energy efficiency programs – are in financial trouble. Such disruptors erode revenue and ultimately could sound the death knell for some companies that traditionally make money based on their capital investments and the volume of electricity they sell.

In response to disruptions in the electric energy sector, modern energy suppliers have emerged. Thanks to data from the Internet of Things (IoT), advanced analytics and artificial intelligence (AI), both new and existing suppliers are adapting to – and even thriving in – the quickly changing energy supply landscape.

Who Is the Modern Energy Supplier?

It depends on who you ask. And it's not singular.

Modern energy suppliers are a collection of entities whose ultimate purpose is to deliver energy to customers. They fulfill a variety of roles and interact with other entities to:

- Generate electric power.
- Transmit it over the bulk delivery system.
- Distribute power to end-use customers.
- Collect a fee that reflects all supply chain costs, including a return to participating business entities.

Modern suppliers are involved in one or more of the supply chain functions described above. And they inherently respond to external factors not directly under their control, such as the rise of electric vehicles. Modern energy suppliers might be described as innovative, socially aware and agile. Their business models vary depending upon core business objectives and regulatory environments, but they generally revolve around performance-based principles and competitive marketplaces.

Compare this to traditional suppliers who manage most or all pieces of the supply chain and are owned by shareholders, which reduces risk appetite. They earn allowed returns on capital investments, but otherwise pass operating and maintenance costs straight to consumers. In this traditional cost-of-service model, end-use customers were historically known as "load" and growth or decline of individual "loads" hugely affects traditional supplier revenues. If gauging the personality of a traditional energy supplier, they could be described as risk averse and focused on maintaining the status quo.

But regardless of the supplier's business model and "personality" type, external forces are driving radical changes across the energy supply chain – from generation and transmission of power to distribution and services. Enterprising modern energy suppliers will take advantage of change, and fill gaps that arise, to create new opportunities for success.

Enterprising modern energy suppliers will take advantage of change, and fill gaps that arise, to create new opportunities for success.

The Forces of Change and Industry Response

The gaps between the current energy supply chain landscape and its future vision are driving change and fall into five categories:

The Sharing Economy

- Peer-to-peer technology matches capacity with demand and increases utilization of energy assets.

Digital Technology

- IoT-based sensors provide new data for machine learning and artificial intelligence applications that affect all areas of the supply chain.

Transmission and Distribution Transformation

- AMI, microgrids, storage, electric vehicles and prosumers have radically changed the T&D landscape.

Customer Expectations

- From high-bill alerts to rapid EV charging stations, customer desires are more closely linked to personal interests than ever before.

Regulation and Liberalization

- Balance stakeholder concerns while modernizing the grid.

Figure 1: The forces of change in the energy supply chain landscape.

Sharing Economy

The success of companies like Uber, Lyft and VRBO was predicated on two fundamentals:

- Underutilized capacity existed in asset fleets that could be profitably tapped to provide value to customers.
- New technology platforms made it possible to match capacity with available demand in these markets.

With regard to the energy supply chain, parallels to Uber, Lyft and VRBO exist. Within the energy supply chain, it is only a matter of time before business value from a shared economy is harnessed. For example, consider the underutilized capacity to generate power and transmit it to customers. With technologies such as blockchain, customers can directly enter into contracts with energy suppliers to tap into these underutilized assets, thus yielding substantial energy cost savings.

A good example of industry response to the emerging energy sharing economy is Japan's TAKE Energy Corporation, which entered into a partnership with Electrify.Asia to deploy its peer-to-peer energy trading platform in Japan's Kyushu region[1].

1 "Japanese Utility Adopts Peer-to-Peer Energy Trading Platform." Smart Energy International. Retrieved from https://www.smart-energy.com/news/blockchain-platform-electrify-japan.

Consumers in Kyushu will be able to trade excess solar energy from the region's solar farms with the ease of use, transparency and security provided by Electrify's blockchain platform.

The sharing economy is moving quickly to tap idle capacity in the energy sector, creating new opportunities for innovative organizations.

Digital Technology

Whether applied to advanced control schemes for wind-turbine generators or better detecting security intrusions in substations, modern digital technology has revolutionized the entire energy supply chain. Among the more dominant technologies exerting forces of change are cloud services, intelligent controls, advanced data management, artificial intelligence, machine learning, streaming analytics and sophisticated visualization.

The data for these applications is largely generated by sensors connected to the Internet of Things (IoT). This new extended IT infrastructure enables new sense and control capabilities, powered by advanced analytics. Utilities are rapidly scaling up their skills in areas of machine learning and artificial intelligence to enhance grid modernization and automation efforts.

Transmission and Distribution Transformation

Digitalization is not the only revolution in the energy supply chain. Advances in science and engineering have made it possible to tap renewable energy sources on a scale not previously contemplated. Consider the capability to store electric energy in central-station battery installations and electric vehicles. Concurrent advances in these technologies provide endless opportunities to reconfigure the energy supply chain in a way that makes the distribution grid more efficient and resilient.

Advances in transmission technology are also profound, as illustrated by widespread deployment of phasor measurement units (PMUs) through the North American SynchroPhasor Initiative. This international community of electric industry members, researchers and vendors is working together to advance the understanding and adoption of synchrophasor technology for enhanced power system reliability and efficiency. For example, San Diego Gas & Electric is using synchrophasor technology to modernize wide-area situational awareness, and online and offline operations support.[2] They are pioneering distribution-level PMU uses and innovative transmission monitoring.

Utility-scale battery storage has also progressed. The ability to store electricity makes it possible to better balance supply and demand, shave peaks, defer large investments in infrastructure, reduce demand charges and provide backup power as needed.

Perhaps one of the more transformative technologies in the energy supply chain is deployment of automated metering infrastructure (AMI). The new generation of AMI meters is packed with capabilities that enhance distribution operations. For example, two-way AMI meters allow utilities and customers to interact to support smart

2 http://newsroom/sdge.com/reliable-innovative/smarter-power-grid-one-phasor-time

consumption applications using real-time or near-real-time electricity data. Smart meters can support demand response and distributed generation, improve reliability and provide information that consumers can use to save money by managing their electricity.

AMI data also provides detailed outage information in the event of a storm or other system disruption, helping utilities restore service to customers more quickly and reducing the overall length of electric system outages. Smart meters provide:

- Insight into loading distribution circuit components that can be used for planning purposes.
- Monitoring power quality to help avoid damage to equipment.
- Remote disconnect capability to avoid dispatching crews when an account is deactivated.

Modern energy suppliers engaged in transmission, distribution and services are now equipping their systems to meet the challenges of the future.

Customer Expectations

Over the past 20 years, energy customer expectations have become more demanding. Whether it's reliability, affordability, communications or community involvement, customers around the globe expect modern energy suppliers to perform at a high level to earn their loyalty.

The American Customer Satisfaction Index (ACSI), a national economic indicator of household consumer evaluations of product and service quality in the United States, reports evidence that supports this view. The ACSI 2018 report[3] states that customer satisfaction with electric service increased slightly from the previous year, although progress has been "glacial." ACSI survey results indicate large variations between utilities, suggesting that some energy suppliers are meeting the challenges of increased expectations while others are falling behind.

Regional examples demonstrate how the industry responds to ever-increasing customer expectations. The UK energy market is characterized by high levels of churn. Since the market opened for competition in 1999, 19 million customers have changed suppliers, with many domestic consumers seeing significant savings on their energy bills. A large number of consumers change electricity or gas suppliers every week – an average switching rate of more than 30 percent.

The need to reduce churn is a key operational focus for energy companies. With this in mind, EDF Energy's Customer Insight team delivers strategic data analysis to gain new insight into the factors that motivate and drive customer behavior. "We can meet customers' needs better by learning more about how they think, what they buy, what they use and how they want to interact with their supplier," says Clifford Budge, Customer Insight Manager of B2C Energy Sourcing and Customer Supply (ESCS) at EDF Energy. EDF Energy's Customer Insight team is helping the business to do precisely that.[4]

---

3 "ASCI Utilities, Shipping, and Health Care Report, 2018." American Customer Satisfaction Index.

4 Understand the Propensity of Your Customers to Defect. SAS customer success story. Retrieved from https://www.sas.com/en_us/customers/edf-energy.html.

Regulation and Liberalization

Regulation modernization has been a prime force for change in the energy supply chain. From "greening" energy generation to restructuring transmission operations, government regulators at all levels – federal, state and local – have imposed numerous new policies and rules on supply chain participants.

Energy regulations have multiple objectives that include ensuring affordable and reliable sources of power for modern society – all by balancing the interests of affected stakeholders. But outside of the energy domain, regulators also imposed new requirements on workplace safety, corporate accounting and operations affecting the environment, to name just a few.

Nowhere is the impact of modernized regulations felt more strongly than at the state level in the US. It is here that public utility commissions define the landscape in which the modern energy supplier operates. The 50 states, each with its own set of regulatory bodies, offer a smorgasbord of strategies for achieving their energy visions and goals. Naturally, this has resulted in a great variety of rules, rates and incentives that vigorously affect the energy supply chain business environment. Still, modern energy suppliers have rapidly adapted to the changing regulatory environment, if for no other reason than to survive without filing for bankruptcy or becoming an acquisition target.

Regulators in many countries (or states in the US) have created policies and funding programs that encourage the deployment of solar energy generation – both small and large scale. The high penetration of solar resources has significantly affected long-range grid planning. For example, Southern California Edison has responded to this challenge by developing integrated distribution planning technology, enabling it to anticipate the impact of distributed energy resources and modify distribution systems accordingly.

Data is also affected by regulation. The European Union's General Data Protection Regulation (GDPR) has had a profound impact on the energy supply chain. Any company – notably those in the energy supply chain – that collects, stores or uses customer data in the EU is subject to these regulations. But the cost of compliance (as well as noncompliance) can be significant, especially for smaller companies without the resources to develop and maintain the required security infrastructure.

Robust retail markets have also emerged in the electric energy sector. Spurred by changes in laws and regulations, competition in the energy marketplace has helped customers realize significant savings while advancing suppliers' future visions of supply across the globe. Following the lead of many European countries, in April 2016 Japan's electricity markets were liberalized, opening the market to retail energy providers who could compete with Japan's 10 traditional utilities. Response from customers has been strong, as indicated by the fact that more than 5 percent switched energy providers within the first year of liberalization.

Utilities in competitive markets have turned to data and analytics to supercharge marketing efforts and woo customers back by earning their trust and creating new value. Adopting retail marketing techniques from best-in-class companies is one way that utilities are transforming into customer-centric organizations.

Advanced Analytics That Enable the Modern Energy Supplier

To succeed, modern energy suppliers must adapt to the fast-paced change occurring in the energy supply chain landscape. Many are implementing IoT-enabled systems and innovative new business processes to provide the capabilities required to support a more agile energy company. Enabling the business with the data analytics platform to support digital transformation is at the top of many CIO agendas, including those at utility companies.

The digital transformation taking place in the grid will realize the most value when paired with advanced analytics capabilities. Below are some of the SAS® solutions that support the transformation to a modern energy supplier.

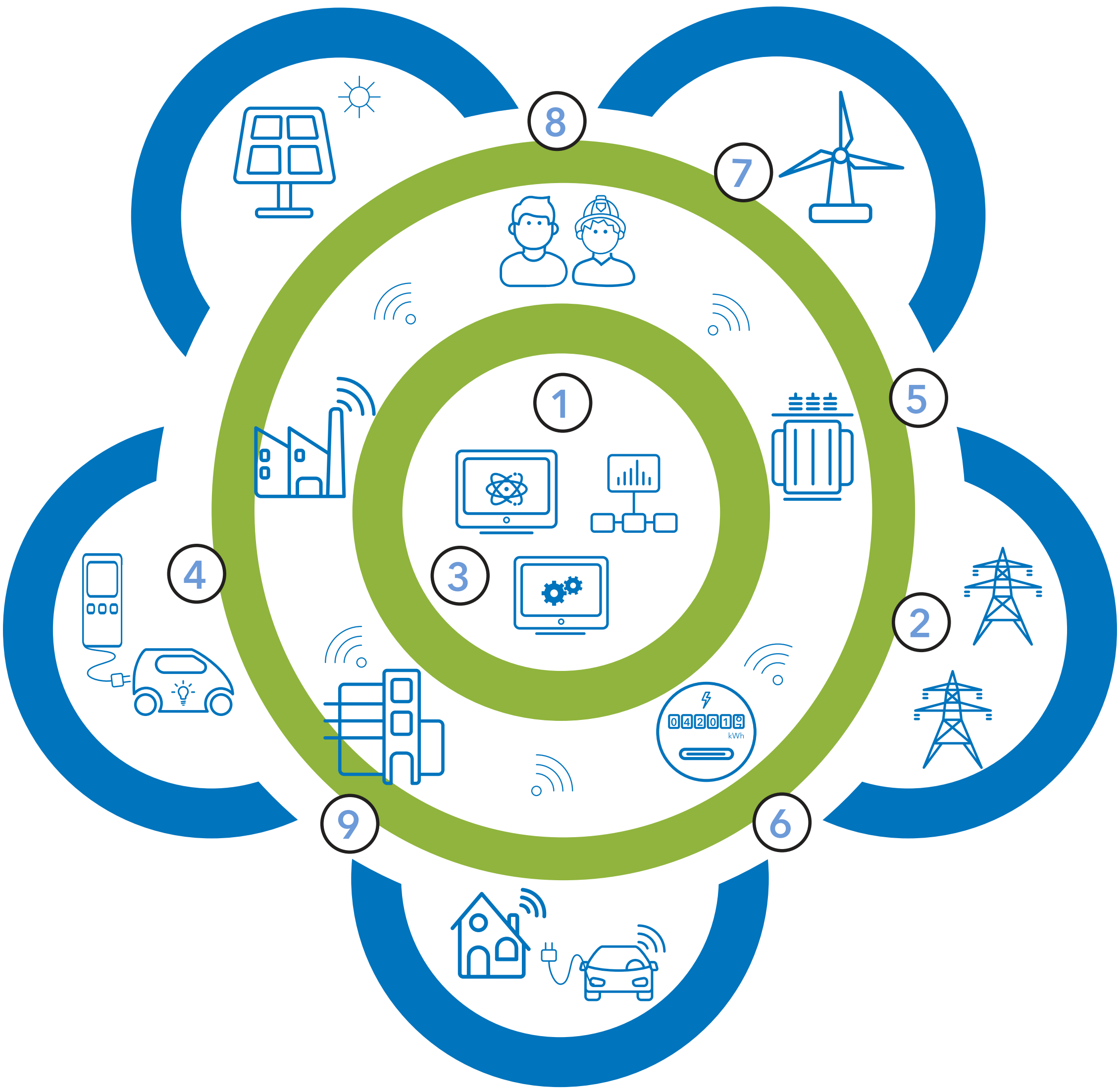

Figure 2: SAS solutions support transformation for the modern energy supplier.

No.	Initiative	Value and Supporting SAS® Solutions
1	**Distribution Circuit Load Forecasting**	The ability to forecast load at intermediate distribution circuit locations provides significant advantages to distribution system planners and operators, such as: • Anticipation of device overloads. • Facilitation of switching operations. • Integration of distributed energy resources (DER) into system operations[1]. *(SAS Energy Forecasting)*
2	**Image Recognition From Drone Aerial LIDAR**	Analyzing imagery instead of sending crews to remote locations can have positive impacts on operational budgets and crew safety. Utilities are applying image recognition to LIDAR captured for vegetation management, line inspections and physical security. (SAS Visual Data Mining and Machine Learning)
3	**Improved Forecasting and Planning Activities**	Artificial intelligence and machine learning are delivering valuable results for utilities in the areas of dynamic forecasting, workflow automation, customer call centers, personalized customer engagement strategies, revenue assurance, cybersecurity and optimized DER management (specifically microgrids). *(SAS Visual Data Mining and Machine Learning)*
4	**Electrification of Transportation**	Building and operating the infrastructure to supply energy to electric vehicles requires a thorough understanding of system power flows, constraints and load profiles. Long-term planning to accommodate transportation electrification gives key stakeholders the ability to raise the necessary capital to fund and execute projects supporting this transition. *(SAS Energy Forecasting and SAS Visual Data Mining and Machine Learning)*
5	**Distribution PMU Analytics**	Phasor measurement units (PMUs) generate data in milliseconds that are indicators of grid stability. Analyzed in real time, distribution PMU data can help detect and isolate faults to minimize the spread of outages. *(SAS Event Stream Processing)*
6	**Smart Meter Analytics**	Insights derived from smart meter data help target usage patterns representative of theft or metering problems. AMI solutions can also provide end-point outage notifications, restoration verification, sensing of momentary outages and voltage monitoring. *(SAS Fraud Framework and SAS Visual Data Mining and Machine Learning)*
7	**Asset Management**	The capability to monitor assets and predict failure with sufficient lead time to take preventive measures is enabled by new data from asset sensors and advanced analytics. *(SAS Asset Performance Analytics)*
8	**Workforce Optimization**	From dynamically staffing contact centers to dispatching crews for storm restoration, efficient work force utilization is a must-do. Solutions to constrained optimization problems, regularly encountered by modern energy suppliers, can lower operations and maintenance costs. *(SAS Visual Data Mining and Machine Learning, SAS Optimization and SAS/OR®)*
9	**Home Optimization for Demand Response**	As utilities strengthen their customer focus, they are implementing initiatives that help consumers understand their current and future energy use, while offering the opportunity to offset their costs through participation in peak load management programs. *(SAS Visual Data Mining and Machine Learning)*

How the Analytics Life Cycle Supports the Digital Utility

New tools and techniques are just the beginning of the transition to a digital utility. At the heart of this adaptation is the ability to collect, understand and act on the information flowing from a wide variety of sources. The analytics life cycle enables these capabilities and ultimately helps ensure the success of modern energy suppliers.

What Is the Analytics Life Cycle?

Successful organizations recognize that analytical models are essential corporate assets that produce and deliver answers to production systems for improved customer relationships, improved operations, increased revenues and reduced risks. Therefore, they seek to create the best models possible.

However, few fully manage all the complexities of the complete analytical model life cycle. It's such a multifaceted task.

The analytics life cycle[5] guides modern energy suppliers through an iterative process of going from data to discovery to deployment (analytics in action). These elements combine to create an iterative process that produces repeatable, reliable predictive results.

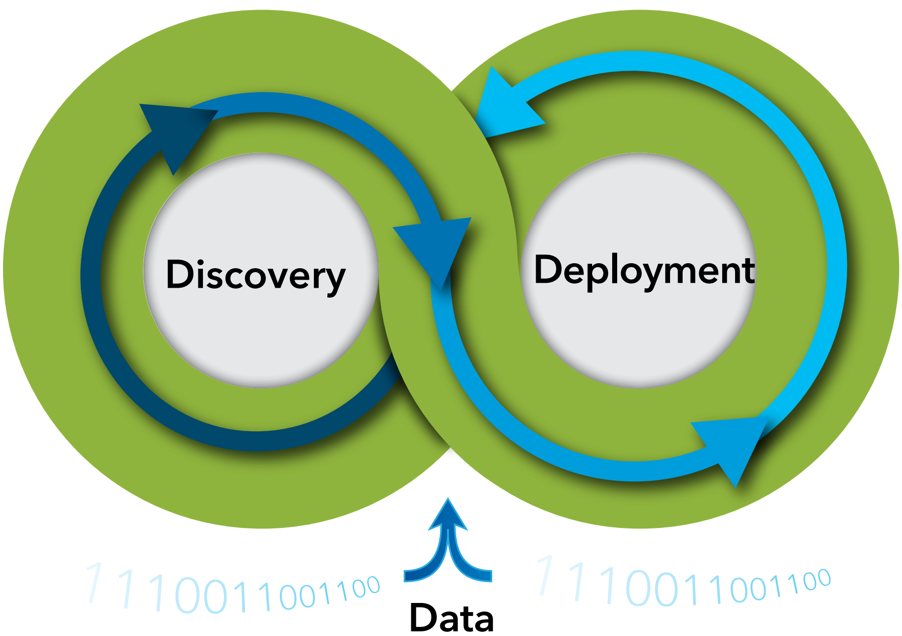

Figure 3: The analytics life cycle guides modern energy suppliers through an iterative process that produces repeatable, reliable predictive results.

5 *Managing the Analytics Life Cycle for Decisions at Scale: How to Go From Data to Decisions as Quickly as Possible*. Retrieved from https://www.sas.com/content/dam/SAS/en_us/doc/whitepaper1/manage-analytical-life-cycle-continuous-innovation-106179.pdf.

Data

Technologies like Hadoop and faster, cheaper computers have made it possible to store and use more data, and more types of data, than ever before. But this has only amplified the need to join data in different formats from different sources and transform raw data so that it can be used as input for predictive modeling. With new data types from connected devices, such as machine sensor data or web logs from online interactions, the data preparation stage has become even more challenging.

Discovery

The discovery process is driven by asking business questions that produce tangible value. So the first step is defining what the business needs to know. Then, the business question is translated into a mathematical representation of the problem, which can be solved with predictive analytics.

Analytical tools search for a combination of data and modeling techniques that reliably predict a desired outcome. There is no single algorithm that always performs best. The "best" algorithm for solving the business problem depends on the data. Experimentation is key to finding the most reliable answer, and automated model building can help minimize the time to results and boost the productivity of analytical teams.

Deployment

When predictive analytical models are embedded into production systems and a business process uses the results to produce instantaneous answers, you have effectively deployed analytical models. Continuous improvement (CI) is fundamental to achieving business value through application of analytics results. CI programs establish the framework that guides you to ask the right questions and then applies analytics insights to improve process performance.

Stated another way, deployment is where you take the lessons learned from the discovery phase and put them into action using repeatable and automated processes. In many organizations, this is the point where the continuous improvement process slows dramatically because there is no defined transition between discovery and deployment, or collaboration between the model developers and IT deployment architects, much less optimized automation.

In most organizations the deployment environment is very different from the discovery environment, especially when the predictive models are supporting operational decision making. Often, IT has to apply rigorous governance policies to this environment to ensure service level agreements with the business. By integrating the discovery and deployment phases, you can create an automated, flexible and repeatable transition that improves operational decisions. Additionally, a transparent, governed continuous improvement process is important for everyone – especially executives, managers and auditors.

Summary

The modern energy supplier operates in a complex business climate. Transitioning to a digital utility is just the first step needed to thrive in a new energy economy. Modern energy suppliers must support data-driven decisions through continuous improvement programs, enabled by an enterprise analytics platform and a well-governed analytics life cycle. This approach embeds agility and flexibility into the supporting IT fabric so that innovative business leaders reduce the time from decision to action – and realize the value for which they're striving.

Learn More

SAS helps modern energy suppliers achieve optimized, sustainable strategies and improved performance in their business processes. SAS solutions enable you to:

- Access and manage what is arguably your most important strategic asset – data.
- Discover insights to propel business performance to the next level.
- Save money by increasing the efficiency of your operations beyond what was previously possible.

More insights and case studies can be found at sas.com/utilities.

To contact your local SAS office, please visit: sas.com/offices