Enabling Energy Industry Transformation through Big Data, Analytics and the IoT

Energy Internet of Things are turning utilities into managers of flexible energy resources writes Dr. Amit Narayan is the CEO of AutoGrid Systems

The US$6 trillion dollar global energy market is undergoing a major transformation. The world is moving away from the use of fossil fuels and towards the use of renewable energy resources. In addition, retail electricity markets around the world are increasingly being deregulated, with established industry leaders facing new competition. These changes are proving to be difficult for utilities and other energy service providers who need to find ways to integrate more intermittent renewable energy resources into their generation portfolios and find new ways to engage with their customers and increase revenues.

To address these challenges, energy service providers are moving away from focusing on ownership of energy generation assets towards a new role in which they balance energy supply and consumption through intelligent management of flexible distributed energy resources. Yet moving away from centralised delivery of electrons to forecasting, optimisation and control of flexible distributed energy resources, on both the supply and demand side, requires a high level of real-time insight on and control over the grid and these resources – levels of insight and control that energy service providers do not currently possess. In their new role as managers of flexible distributed energy resources, big data, predictive analytics and the Internet of Things (IoT) will be essential. With these technologies, energy service providers can create an Energy Internet of Things (EIoT) that not only provides them with a living portrait of the grid, but also with the ability to manage a vast array of flexible distributed energy resources, ranging from solar power systems and energy storage systems to smart thermostats and Electric Vehicle (EV) chargers. With big data, predictive analytics and machine to machine (M2M) communications, energy service providers can collect and process petabytes of data streaming from millions of IoT connected assets across the entire energy supply chain, providing them with the intelligence and control they need to forecast and optimise electricity supply and demand across the grid, in real-time and at scale.

Increase Customer Engagement

By embracing big data, predictive analytics, IoT and other EIoT technologies, energy service providers will also increase engagement with and deliver significant benefits to their customers. These EIoT technologies will help customers with solar power, Combined Heat and Power (CHP) plants, and other on-site energy generation resources sell the electricity generated by these resources to energy services providers, increasing the value of these assets. They will make it easier for customers to use their energy storage systems to predict (and reduce) demand charges or earn revenue through participation in energy markets or other grid flexibility programmes. EIoT technologies will also help energy service providers automate and expand demand response programmes to more IoT devices; providing customers with greater choice over the types of IoT devices they use for these programmes, while also increasing the amount of money these programmes save them in energy costs. By engaging customers as active participants in the energy value chain, rather than as passive price-takers, energy service providers can use EIoT technologies to provide their customers with significant benefits, while also strengthening their customer relationships.

Enabling Management of Flexible Energy Resources

How are energy service providers using big data, predictive analytics and the IoT to forecast, optimise and control flexible distributed energy resources today? One way is through using these technologies to implement more effective Demand Side Management (DSM) programmes for their residential, commercial and industrial customers. These DSM programs include:

Behavioral Demand Response (BDR) and dynamic pricing programs that use Advanced Metering Infrastructure (AMI) to make these types of programs a reliable, cost-effective energy resource.

Bring Your Own Things (BYOT) initiatives that allow customers to choose which IoT devices they want to enroll in demand response programs that reduce peak demand.

Fast responding, fully automated commercial and industrial 24x7x365 demand response that allows energy service providers to balance out intermittent renewable generation.

EV charging demand response programs that enable customers to lower the cost of EV ownership by choosing to slow or suspend charging of their EVs during demand response events. As EV ownership increases, these types of programs will grow in importance.

Controlling Flexible Resources with a Software-Defined Power Plant

For a specific example, we can look to Northern Europe. Here a utility is using big data, predictive analytics and IoT technologies to add more renewable energy to its generation portfolio and reduce grid imbalance charges. The utility is using these technologies to implement a software-defined power plant that integrates customer-owned Combined Heat and Power (CHP) units in greenhouses, industrial demand response, and other flexible distributed energy resources into a single, reliable resource. The utility can use this software defined power plant to forecast, optimise and control this network of flexible distributed energy resources in real-time and at scale. With this dispatch-grade resource, the utility can react in real-time to market signals from wholesale electricity markets and trade in these markets 24 hours a day, seven days a week, 365 days a year.

Using Internet-connected EV Chargers to Reduce Peak Demand

Another example can be found in the United States, where a utility is using big data, predictive analytics and IoT technologies to build an EIoT solution that allows it to study how EV owners respond to different pricing incentives at their homes and at the workplace, providing them with insight into how they can use EV charging demand response programmes to reduce peak load demand and improve customer engagement. EV owners participating in the study can charge their vehicles at prices lower than normal if they agree to slow or suspend charging during a utility scheduled peak load event. After opting into the programme no action by the customer is necessary – the EIoT solution connects to the customer's EV charger to slow or suspend charging when a peak load event occurs. The EIoT solution can also be used to forecast expected EV customer response to demand response events, to communicate with customers' EV chargers, and to perform post-event measurement and verification. With the EIoT solution, the utility is securing valuable knowledge on how its customers respond to incentives for charging electric vehicles at home and at the workplace, helping them ensure that they design these programs so that they both reduce the utility's peak load and increase customer satisfaction by helping EV owners reduce their EV charging expenses.

Overcoming Technology Challenges

In the past, many of the big data, predictive analytics, IoT and other EIoT technologies required to implement the projects described above were difficult for energy service providers to deploy. They required investment in on-premise computer hardware and software. The M2M communications needed to connect to IoT devices were still being developed. The computer power and big data and predictive analytics software needed to process the massive amount of energy data required to implement these projects was expensive or did not exist. Yet today, cloud computing and Software as a Service (SaaS) have made on-premise solutions unnecessary. Robust M2M communications standards, such as OpenADR and SEP 2.0, have been developed that enable energy service providers to connect with and control CHP power plants, energy storage systems, smart thermostats and IoT devices. Cheap computing power and sophisticated, scalable energyspecific big data and predictive analytics software can now accurately forecast the power consumption of over one million endpoints simultaneously every 10 minutes on a medium-size cluster running on commodity hardware servers. In addition, fog computing now enables much of the analytics for these tasks to be moved to the grid edge, further supporting the implementation of forecasting and optimisation programs in real-time and at scale.

A Cleaner, More Affordable, More Reliable Energy Future

Distributed energy resources, such as renewable energy and energy storage, and new types of demand management and grid-flexibility programmes provide hope that we can move away from our dependence on fossil-fuel energy resources. However, without big data, predictive analytics, IoT and other EIoT technologies to provide intelligence and control over these resources, they cannot be forecast and optimised, and their adoption will be slow and expensive. With these technologies, energy service providers can accurately forecast how much energy these resources will be able to provide in the future and also control how these resources are used. These EIoT technologies are accelerating energy service providers' transformation into managers of flexible energy resources, allowing them to address the challenge of developing a new energy supply system that is clean, affordable and reliable.

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