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insideBIGDATA Guide to

Energy

How big data can help energy companies manage intense disruption

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Introduction

The energy industry has always faced large price swings as a result of changes in the global economy. But today, this entire sector is facing an unprecedented level of disruption. Industry analysts say it is in the throes of a dramatic upheaval that is requiring companies in this industry to reinvent themselves.

> "The period between 2020 and 2030 will emerge as the 'decade of deep redesign' because all oil and gas companies will need to make significant changes in their investments and operations."
>
> *– Gartner*

For example, Gartner recently warned, "Oil and gas CIOs face a chaotic and confusing business environment that is likely to continue through the next decade." They added, "The period between 2020 and 2030 will emerge as the 'decade of deep redesign' because all oil and gas companies will need to make significant changes in their investments and operations."

To navigate this period of intense uncertainty, many energy executives are looking to big data analytics to point the way. According to Mordor Intelligence, "The big data analytics market in energy sector is expected to grow at a CAGR of 11.28%, during the forecast period, 2021-2026. Big data analytics play a crucial role in reducing energy consumption and improving energy efficiency in the energy sector."

This paper will:

- Take a closer look at some of the biggest disruptors affecting energy companies

- Examine how big data analytics can help these firms reduce risk, drive down costs, and improve efficiency.

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Current energy industry disruptors

Part of what is making this period of time so difficult for energy companies is that the disruption is coming from multiple directions at once. Some of the biggest sources of this disruption include the following:

Climate change

Global climate change is affecting energy companies in at least three significant ways.

Weather patterns

First, changes in weather patterns are altering energy demand and hindering the ability of the energy sector to meet that demand. In recent years, extreme weather events and natural disasters have become much more common. The World Meteorological Organization reported, "A disaster related to a weather, climate or water hazard occurred every day on average over the past 50 years — killing 115 people and causing US$ 202 million in losses daily. . . .The number of disasters has increased by a factor of five over the 50-year period, driven by climate change, more extreme weather and improved reporting."

In the United States, examples of this extreme weather include the California drought and wildfires that made it difficult for grid operators to get power to their customers. And on the opposite end of the spectrum were the 2021 winter storms in Texas that drove demand to unprecedented heights and nearly caused the grid to fail.

Regulation

Second, not only do energy companies need to deal with direct impacts from climate change, they also must comply with increasing regulation as governments attempt to reduce greenhouse gas emissions and mitigate global warming. Agencies around the globe have set ambitious targets that energy companies must meet if they want to stay in business. Recognizing their role in this crisis, many energy companies are challenging themselves to exceed those deadlines.

Alternative energy investment

And that leads to the third big impact of climate change — investment in alternative energy. According to Deloitte, "Renewable energy growth

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> *— The World Meteorological Organization*

is poised to accelerate in 2022, as concern for climate change and support for environmental, social, and governance (ESG) considerations grow and demand for cleaner energy sources from most market segments accelerates. At the same time, the Biden administration's vision to fully decarbonize the US economy is helping spur activity in the renewable sector that will likely drive further growth — particularly if proposed legislation is enacted." Companies are racing to develop solar, wind, hydropower, and other clean energy. While this new development represents a significant opportunity, it also requires energy companies to radically transform themselves.

New technologies

At the same time that energy companies are developing alternative energy to help them respond to climate change, they also face the challenge of integrating other new technologies into their organizations if they want to remain competitive.

Digital transformation has affected every industry, and the energy sector is no exception. Companies of all kinds are looking for ways to do more business online and to become more data driven. Every firm in the energy industry knows that its competitors are using technology to become more efficient and responsive to customers, and they have to do the same if they want to keep up.

In addition, technology trends like the Internet of Things (IoT), smart grids, and smart cities are changing the marketplace. Energy companies have more data at their fingertips than ever before.

As the U.S. Department of Energy noted, the electric industry sector is facing an "explosion" of data coming from a variety of sources. Some examples include:

- Field measurements: smart meters, synchrophasors, smart sensors
- Weather measurements: ground stations, radar, satellite, and specialized systems such as the National Lightning Detection Network
- Asset monitoring: embedded sensors for condition-based monitoring
- Distributed generation data, data about electric vehicle charging, customer-driven data: Internet of Things devices, smart meters, demand response devices
- Other important data sources for outage management: animal migration, vegetation management, fire detection, and water and gas management.

This data explosion provides companies with valuable information that can help them improve their business, but the technologies themselves also drive up demand, requiring firms to invest in new infrastructure to meet this demand.

International conflict

Because the energy market is a global market, what happens in one relatively small country can have a huge impact on worldwide energy prices. Conflicts, like the war in Ukraine, can drive up prices for gasoline, natural gas, and electricity. They can also disrupt the energy supply and transmission.

In addition, energy facilities can themselves become military targets — of both physical attacks and cyberattacks. Responding to these kinds of threats can pose an existential threat to energy companies.

COVID-19

As if all that weren't enough, energy companies are still dealing with the fallout from the global pandemic. During the COVID-19 crisis, energy companies have experienced the same supply disruptions that companies in other industries faced. Getting the equipment and parts necessary to build and maintain infrastructure has been challenging for many organizations.

And as business managers are well aware, the pandemic also led to talent shortages. Many of the jobs in the energy industry are physically challenging— sometimes even hazardous. During the pandemic many workers re-considered their previous career choices and moved on to other organizations, leaving their employers scrambling to keep the lights on — sometimes quite literally.

Energy companies simply cannot continue doing things the same way they always have if they want to remain competitive.

Competition

The deregulation of the 1980s and 1990s led to a much more competitive marketplace, which continues to be the norm today. Customers have more options, leading to much higher churn as customers seek out the best deal. And the switch toward alternative energy is attracting many startups, which has only increased the level of competition.

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Cost of exploration

Another ongoing challenge is the increasingly high cost of obtaining gas and oil. The process of oil and gas exploration is not cheap. If a particular well doesn't pan out, companies face significant losses.

In addition, energy companies have already tapped into most of the natural reserves that are "easy" to extract. While natural resources are still extensive, obtaining them isn't always cost effective. Companies may have to drill deeper, in less hospitable environments than they have been in before. And in some cases, they have needed to develop new technologies to be able to tap those reserves.

Energy companies need every advantage they can find when the risks are this high and the competition this intense.

13 ways big data can improve efficiency and drive down costs in the energy industry

While these disruptors represent significant challenges, companies are finding ways to overcome those challenges by investing in big data analytics.

It's worth noting that big data isn't a simple or easy solution to any of the problems energy companies face. In order to do analytics well, you need the right mix of talent, hardware, and software. You need clearly defined problems, targeted objectives, and executive support to shepherd the project.

Putting all those elements into place is very difficult. According to some estimates, between 60% and 85% of all big data projects fail.

But the potential upside is so significant that most energy companies are investing significantly in big data technology.

What are those potential benefits? Here are 13 ways that big data analytics is helping energy companies manage the current level of disruption.

1. Better weather prediction

Today, energy companies have access to much more weather data than has ever been available before. Many have their own weather sensors installed on key equipment, and they also subscribe to both paid and free sources of weather data.

Many have also invested in advanced servers or built supercomputers that can enable them to apply artificial intelligence (AI) or machine learning (ML) techniques to that data. This allows them to create highly accurate, localized weather forecasts. Armed with this information, they can make adjustments that allow them to better prepare for and respond to extreme weather events. While better weather prediction can't stop or slow climate change, it can make it easier for companies to deal with natural disasters caused by climate change.

2. Faster research

Big data analytics can also speed the process of conducting research. Whether companies are searching for hidden oil reserves, inventing new types of photovoltaic panels, testing batteries

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for energy storage, choosing locations for wind turbines, or doing other scientific work, big data analytics can help the process go faster.

Today's servers are capable of volumes of calculations that would have been nearly impossible just a few years ago. That means companies can analyze more data much more quickly than ever before. That can help them make breakthroughs that might slow or mitigate global warming.

3. Preventive maintenance

Every energy company relies on equipment of some kind to help them produce, transmit, and/or deliver energy to consumers. Today, a growing number are installing IoT sensors that can detect minute changes in the way the equipment is operating. By performing advanced analytics on this data, they can predict in advance when a particular piece of equipment or part is going to need repair.

This information allows firms to schedule maintenance at a time when it is least disruptive to their operations. For example, if a utility knows that a transformer is likely to fail in the next two weeks, they can take it offline for repairs overnight when demand is low, making it easier for the rest of the grid to compensate.

4. Pipeline integrity

Companies that transmit oil and gas through pipelines can use a very similar process to detect and prevent future leaks. Spilling a large volume of oil and gas can be disastrous for both the environment and a company's reputation.

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By installing sensors at key locations on the pipeline, companies can detect small changes in pressure, temperature, flow, density, or other factors that might indicate problems. In some cases, they can also use computer vision techniques or ultrasound to detect cracks or dents in the pipe that could eventually result in a leak.

And if the worst happens and a leak occurs, these sensors provide the information to the companies right away, as well as allowing them to use analytics to determine the best response.

5. Security analytics

Most energy companies deal with near-constant cyberattacks — sometimes from state actors as part of ongoing cyberwar and sometimes from ordinary cybercriminals hoping to make a buck or sow chaos.

> Many of today's best cybersecurity tools use machine learning models to define a baseline "normal" level of activity on corporate networks and then immediately spot anything out of the ordinary.

Security professionals often feel like they are falling behind. As quickly as they can come up with defenses, bad actors are coming up with brand new kinds of attacks that companies have to figure out how to detect and prevent.

One of the most successful strategies for dealing with these evolving threats has been to rely on big data analytics. Many of today's best cybersecurity tools use machine learning models to define a baseline "normal" level of activity on corporate networks and then immediately spot anything out of the ordinary. These tools aren't foolproof, but they can make energy companies safer.

6. Seismic surveys

For several decades, oil and gas companies have been relying on seismic surveys to help them locate deposits within the earth. After setting off small explosions, they use a seismic array to measure the waves as they flow through the earth's crust, allowing them to create a visualization of what lies beneath the surface.

Today, geologists must look much deeper to find the oil and gas they are looking for. That requires larger arrays that generate much more data — generally terabytes or petabytes. To handle that much data, companies need hardware with scalable storage, fast processors, and advanced graphics processing units (GPUs) that will allow them to conduct analytics on their survey data to find the resources they are looking for.

7. Geophysics simulations

Scientists combine seismic survey data with other data to help them build geophysical models. These models are incredibly valuable because they allow oil and gas companies to predict with a high degree of accuracy where they will find underground reserves, as well as the likely volume and quality of those reserves.

Today's models are far more complex than those created in the past, relying on much larger volumes of data and frequently incorporating advance ML techniques. Again, this requires powerful servers similar to what is required for processing seismic surveys.

8. Talent management

Today, attracting and retaining high-quality workers is a make-or-break proposition for many energy companies. Because competition is so fierce, many companies are investing in talent management software to help them accomplish these goals. The best of these systems rely on big data analytics to identify the best candidates. Some companies are also turning to predictive systems that attempt to identify staff members who are likely to leave the company so that managers can take action to try to get them to stay. But in order to make these predictions accurately, the systems need a high volume of data.

> By combining supply chain management tools with big data from other parts of the organization, firms can improve the quality of the insights they are gaining, speed up operations, and reduce risk.

9. Supply chain management

While no amount of data can make computer chips or other equipment magically appear when none are available, big data can enable better visibility into the supply chain, and big data analytics can improve forecasts about which supplies are likely to be necessary. Energy companies have long used supply chain management tools to keep tabs on the flow of equipment and goods. By combining these resources with big data from other parts of the organization, firms can improve the quality of the insights they are gaining, speed up operations, and reduce risk.

10. Predictive consumption models

Using advanced predictive analytics and ML algorithms, data scientists can create more accurate models of consumer energy use under various scenarios. Using these tools to analyze historical energy data can't tell you when international conflict or extreme weather is going to occur, but it can tell you what is likely to happen when events like these take place. That can help firms plan ahead so that they can better meet demand and keep the world supplied with the energy it needs to function. It can also help them reduce the risk that they will miss out on potential revenue because they are unable to keep up with demand.

11. Predictive price modeling

Data scientists can also apply similar modeling techniques to pricing, allowing them to forecast with some certainty what is likely to happen to energy prices in different situations. This information can help oil and gas companies decide when, where, and whether to drill. It can help refineries decide whether to increase capacity or close plants. It can help utilities more accurately set prices for the energy they deliver to businesses and consumers. And it can help energy companies of all kinds become more competitive.

12. Speed

The process of delivering energy to end users is long and complex. Big data analytics doesn't make any one piece of this process dramatically faster. However, it can make nearly every step a little more efficient. Taken as a whole, these improvements can have a cumulative effect of making companies able to execute on their plans significantly more quickly. That speed can be tremendously important as companies seek to keep up with the competition and respond to the current disruption in the marketplace.

13. Agility

Speed is closely related to agility. By their nature, most energy companies are not naturally agile. You can't drill an oil well or build a new power plant in a day. And once projects like this are underway, changing your mind carries a huge amount of risk. But the speed afforded by big data analytics can help organizations make good decisions more quickly. In an industry not known for quickly reacting and adapting to change, any improvements in this area can make a significant impact on the bottom line.

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Looking ahead

Most analysts believe that this period of intense disruption in the energy industry is likely to continue at least through the end of this decade. And the effects of climate change will probably only intensify for many decades to come.

Fortunately, organizations have growing amounts of big data from a wide variety of sources to help them deal with this disruption. The firms that navigate this period of time most successfully could very well be those that do the best job of converting their big data into actionable insights that can guide their decision making.

How to build an environmentally friendly data center

Energy companies face a dilemma: In order to deal with the challenges created by global warming, they need very powerful computing infrastructure that can perform the big data analytics that can give them the insights they need. But those powerful computers themselves can add to global warming, making it difficult for companies to reach their sustainability goals.

Fortunately, it is possible to create a very powerful data center that is also environmentally friendly.

For example, the University of Cambridge Research Computing Services built one of the world's greenest supercomputers, the Wilkes 3, with Dell PowerEdge XE8545 servers. In fact, the Wilkes 3 is currently fourth on the Green500 list of the world's most energy efficient supercomputers.

The Wilkes 3 system includes 80 nodes with 26,880 cores in its AMD EPYC 7763 processors. The EPYC chips are the world's highest-performing x86 server CPUs, which is ideal for workloads like big data analytics. Augmenting those CPUs are 320 NVIDIA A100 GPUs, which help the system achieve 4.5 to 5 petaFLOPS of computational power while driving down the overall energy consumption.

Another organization that used Dell PowerEdge servers featuring NVIDIA GPUs to create an environmentally friendly supercomputer was the Italian firm Eni. In this case, the company chose to use solar power for its data center, making the installation even more sustainable.

Dell Technologies is committed to advancing sustainability through its processes and products, including its advanced server hardware for big data analytics.