Over the last decade, technological advancements have had a profound impact across the North American energy markets. The development and deployment of renewable energy sources – particularly wind and solar – have flooded the power markets with new capacity and reshaped the economics of power generation. In oil and gas, the development of long-reach horizontal drilling and massive hydraulic fracturing technics has opened previously unproductive reservoirs and moved the US to the forefront of global oil and gas producing countries. The profound impacts of these technology advances have had a disruptive effect on local, national and even global energy markets, and have had further and significant knock-on effects in the North American markets – including early retirement of coal-fired generation, increased reliance on natural gas for power generation, development of LNG export facilities, and massive investments in construction of upstream and mid-stream oil and gas gathering and transportation infrastructure, to name just a few.

These changes have not only impacted the physical operations of these markets, they have also had fundamental impacts on the economics of energy trading, and the underlying information technology landscape. The influx of new energy sources has depressed prices, reduced volatilities and seemingly forever changed price correlations among energy commodities ... ultimately leading to lower margins for traders and increased difficulties in maintaining profitability for energy trading companies.

Traders and marketers have been challenged in addressing these market changes as many have found their existing software systems, business processes, and analytic tools and models have been unable to keep pace with the influx of new data sources and volumes of information streaming from these rapidly changing markets. Fortunately, just as the markets themselves have been transformed by technology advances, there are a number of new software-based technology advances that could potentially not only address these challenges, but could ultimately disrupt established business processes and reshape the very nature of trading in the not too distant future.

In this paper, we will describe some of these potentially disruptive technologies that are starting to immigrate into energy and commodity markets, including some new and/or emerging use cases, and discuss their potential to disrupt the business processes of the North American wholesale energy markets.

What are the potential disruptive technologies that may impact the North American energy markets?

Advances in web-delivered solutions and in the capture and analyzing of huge sets of data, commonly known as “big data”, have revolutionized the retail consumer markets in the U.S. – substantially moving retail buyers away from brick and mortar stores and into the virtual stores of the internet. These same technologies, and others, are now being investigated and in some cases applied to various corners of the energy markets – and could potentially lead to similar levels of disruption. Most often mentioned by market analysts, industry press and by market participants themselves, the new technologies range from cloud computing to artificial intelligence (AI) to blockchain.

Of this group of potentially disruptive technologies, cloud-based solutions are certainly the most mature and the furthest along in terms of adoption and deployment in the energy markets. Cloud-native applications, those that have been specifically architected to take advantage of cloud-based technologies (either public or private) as opposed to these solutions converted to run in the cloud, are clearly the most impactful as they have been designed to take full advantage of that environment. The capabilities of these cloud-native applications, including the auto-provisioning of new technologies, auto-scaling of processing resources and ability to access cloud micro-services, have the potential to reshape how companies not only acquire and deploy new technologies and solutions, but also at a lower total cost of ownership (TCO) that would be found should those companies seek to deploy similar capabilities on-premises. That said, is "cloud" a truly disruptive technology? As Warren Street, head of Cloud Services at FIS notes, "Cloud, by itself is probably not a truly disruptive technology. However, cloud enables innovation and the rapid evolution of solutions that can’t be accomplished economically via an on-premises solution. Cloud should not be viewed as a destination unto itself ... rather it’s a valuable and necessary step in deploying other truly disruptive technologies in the future." He notes that the virtually unlimited computing resources of the cloud will enable other technologies, such as AI and machine learning, and ultimately lead to a “cultural shift into uncharted territory. These technologies will lead market participants to think differently about how business can be conducted.” Nima Safaian, head of Trading Analytics with Calgary-based, integrated oil and gas producer Cenovus, echoed these sentiments. “The cloud provides the ability to scale innovation and address problems and opportunities without being limited and bound to an existing infrastructure.”
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Blockchain – or perhaps more accurately, distributed ledger technology – has received attention, and is attracting huge investments, from virtually all markets, including energy trading. As the “engine” behind cryptocurrency markets, blockchain provides a fully trusted trading network without the need for a central authority. It is the ability to create “trust” via smart contracts and immutable records that is the primary draw of the technology. To date, several trial, or investigatory blockchain-based exchanges have been developed with the backing of leading market participants, including companies such as Shell, BP, and Mercuria. Early trials of these systems have shown promise, particularly in the oil markets, by demonstrating some improved efficiencies, particularly in the settlements process. In the U.S., small-scale power exchanges are also currently being developed using blockchain as a platform, though they cover limited areas (as small as an apartment block), to facilitate the trading of power within an established microgrid.

One such exchange in Brooklyn, NY, allows customers that own their own generating assets (in this case, solar panels) to buy and sell power among their neighbors via a blockchain-based exchange. This microgrid project, a partnership between LO3 Energy and Siemens and called the Brooklyn Microgrid, allows participants to sell their power at times they are not consuming all that they produce, or to buy additional supplies when their demand exceeds the capacity of their panels. The system also allows non-producing customers to purchase on the exchange, without the burden of the fees that utilities normally charge for infrastructure cost recovery and maintenance of generating and transmission assets.

While these early efforts have shown promise, issues do exist that may ultimately limit the appeal and adoption of blockchain and limit its impact as a disruptive technology that could displace the long-established exchanges and other centralized trading authorities. Of particular concern is the inherent latency of the technology, a problem that increases in magnitude as more entities, and subsequent “blocks”, are added to the system. Also of concern is the necessity for those participating in a blockchain-enabled marketplace to adopt and adhere to a common standard of commercial practices – meaning that each participant will have to sign on to the terms, conditions and data standards that were established by the founding members.
of that market. This issue could be particularly problematic in the wholesale energy markets as many of those companies view their commercial processes and portfolio of assets to be a competitive advantage.

AI is not so much a technology itself, but is probably more aptly defined as a technology category or an umbrella of technologies that utilize data gathering and analytics to make decisions that do not require human intervention – essentially taking humans out of the decision-making process. AI-enabled technologies are being adopted and used in many financial markets to better identify trading opportunities, and in some cases, to actually execute trades. These systems, which monitor market activity, macro and microeconomic conditions and events, can consume data and information, and calculate appropriate actions more quickly than can their human counterparts.

In the U.S., an aging power infrastructure has led to numerous power outages, including the great Northeast blackout in 2003. Given the grid’s importance to the economic health of the country, the Department of Energy (DOE) has made grid security and operational fitness a national priority. Since 2010, the DOE has invested, by grants, more than $4.5 billion in supporting smart grid technologies in the U.S. Leveraging the over 15 million smart meters and million more field-level sensors, the smart grid will increasingly rely on AI technology to help monitor and analyze huge real-time data sets to balance loads, identify faults and continuously monitor and adjust assets across the country.

In terms of private investment in AI-enabled power technologies, AES Corp. announced last year that it will begin leveraging AI tech to improve monitoring, maintenance and efficiency of its various assets, including numerous large scale solar installations. Though the company has indicated that its use of AI is still in the exploratory phase, it appears fully committed to incorporating AI technologies as a primary means of improving reliability and efficiency for its hundreds of thousands of customers.

Machine learning, another branch of the AI category, uses statistical analysis to enable systems to continuously improve their performance through constant data analysis, including continual improvements in the analytic models themselves. These software systems learn from the data they consume – identifying patterns and making independent decisions to achieve programmed goals without human intervention. Most of the work and investment to date in machine learning in the energy space has been focused on developing advanced weather modeling techniques for wind and solar producers. Using advanced neural networks to analyze massive sets of historical weather data and field sensors, these systems have the potential to create more granular/site-specific forecasts and improve the accuracy of dispatch or demand forecasts for individual assets within a renewables fleet.

Robotic process automation (RPA) is similar to machine learning in that the systems of RPA utilize software robots that can recognize events and act in a preprogrammed manner more quickly and more accurately than humans. Though this branch of technology is still evolving and, as of now, not fully leveraging AI, software robots are currently being used in various industries, such as algorithmic trading solutions in financial and some real-time energy markets. Though widespread adoption of software robots outside of algo trading has not yet occurred, a number of technology firms have begun work to identify opportunities to deploy RPA robots in various ways to reduce reliance on those human workers whose sole role is to perform computer-based repetitive tasks such as data matching/reconciliation and transaction processing. Further, as AI capabilities are increasingly incorporated into more energy-centric solutions, AI-enabled software robots will offer increased opportunities for deployment and an improved value proposition for the user.

**Where will these technologies have the greatest impact?**

The applications of these disruptive technologies can be generalized as those that improve operational efficiencies or those that improve commercial/trading performance. Clearly, based on the cited examples, most of the current investment is in the area of operational improvement, and more specifically, asset optimization. For companies that hold generation, production, transportation or processing assets, AI and its associated technologies, like machine learning, hold significant promise in improving the performance of those assets, reducing downtown or interruptions and ensuring each asset is operating at its optimal level and optimal profitability.

Commercial activities, such as trading or marketing, are really just at the cusp of adoption of these potentially game-changing technology advances. While current opportunities to embrace many of these technologies are somewhat limited in the sphere of trading at this time, the cloud and native cloud solutions provide the channel and platforms to access them, facilitating their rapid on-boarding and use as they become more readily available. In fact, for companies that seek to maintain pace with a rapidly changing market or potentially gain advantage via the use of these disruptive technologies, the cloud should be viewed as the critical first step.

Blockchain and algorithmic trading of physical commodities (particularly in the European real-time power markets) have seen significant interest and, as noted, a number of companies are making multi-million-dollar investments in research, pilots and deployments of these technologies in order to advance their commercial operations. Given the track record of the successful use of algorithmic solutions, there is little doubt that as they become smarter through the use of AI-enhanced skills, their adoption in energy markets will increase.
The early results from blockchain trials in oil trading and shipping logistics and in trials in European power trading with Enerchain (the Ponton-led consortium of producers and large-scale consumers) have been promising; however, its current limitations may make its adoption in highly liquid, fast-moving markets less certain. Should the technical obstacles of blockchain prove insurmountable in these markets, many experts believe that the core concepts of blockchain – engendered trust via smart contracts and immutable records – combined with the lessons learned in its research, will provide the blueprint for similar capabilities using a yet-to-be-determined technology.

AI has perhaps the greatest opportunity to impact energy trading. As Nima Safaian told us, “We are already seeing machine learning and AI starting to impact analytic capabilities across many markets … (and) we are investing in the skills and knowledge required to leverage these technologies.” Data analytics has always been a key component of any successful trading business. However, as the sources and velocity of data increases, the ability of any individual to analyze these streams and find trading opportunities has practically reached its limits. AI-enabled analytics solutions have the potential to free up the time and effort spent on data analysis by traders and support staff, and allow these high value resources to focus more on strategic opportunities and less on running cumbersome and increasingly outdated software processes or Excel-based models. As Mr. Safaian describes the adoption of AI-enabled technologies, “AI is not about replacing people, nor will its adoption result in the full automation of trading processes. Ultimately, AI solutions should, and I believe will, provide support to human workers, enabling those valuable resources to make the best use of their skills.”

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