ISSUE 9: ARTIFICIAL INTELLIGENCE

Landis+Gyr

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artificial intelligence: the future brain of the smart grid

This 9th issue of pathway couldn't have a more relevant theme as we continue to explore the groundbreaking megatrends that are radically transforming the energy sector. In previous issues, we focused on the digitalization of the energy industry and the rise of an increasingly interconnected IoT world – both generating huge amounts of data. Turning these data into added value remains a challenge for all market players. This is where artificial intelligence (AI) comes in with its enormous potential to enable smarter, data-driven decisions.

But how exactly? We aim to provide answers to this question by taking a closer look at artificial intelligence with the help of recognized experts from different industries. Illustrating the significant capacities of AI from various angles clearly shows that its areas of application are unlimited – ranging from forecasting or balancing demand and supply to predictive maintenance and enhanced value for customers, just to name a few.

At Landis+Gyr, we believe in the power of AI as a key enabler of a new, data-reliant energy system. If we consider AI as the "brain of the smart grid" and embrace its vast opportunities, we will manage to shape an energy system with an unprecedented level of intelligence and efficiency. With this in mind, let's start using AI to its full potential together.

Enjoy the read!

Susanne Seitz
Executive Vice President EMEA
and Member of the Group Executive
Management of Landis+Gyr

contents

understanding
artificial intelligence

Stockfish and Deep Blue can beat world chess champions, Alexa can recognize your voice, your spam filter curbs annoying emails and your credit card provider can spot fraud. But real artificial intelligence goes much further… it's about having a machine that learns, thinks and makes decisions in much the same way as a human.

artificial intelligence (AI)

AI is a broad term that refers to machines acting intelligently. It focuses on creating systems capable of using data to learn, decide, solve problems, plan, adapt and continually improve performance. AI has long caught people's interest and imagination, including in its most famous sci-fi forms: HAL 9000, Terminator and Skynet.

narrow artificial intelligence (NAI)

Narrow artificial intelligence, or 'weak AI,' involves machines focused on performing single narrow tasks – usually binary questions that the computer program asks in sequence until it can provide a relevant answer. Used to automate repetitive service tasks, NAI examples include Internet bots and Apple's virtual assistant, Siri.

artificial general intelligence (AGI)

Also called 'strong AI,' 'full AI' or 'human-level AI,' AGI is machine intelligence that performs a task as well as or even better than a human, and with no requirement for programming in advance. Combining human-like flexible thinking and reasoning with super-fast data processing, AGI could soon be reality.

machine learning

A field of AI, machine learning centers on algorithms that use often large volumes of data to continually increase efficiency and performance while completing tasks. It involves getting computers to learn, act and improve with experience without being explicitly programmed, and without the need for human intervention.

what the energy industry gains from AI

Supply and demand optimization

Machine learning can be used to automate and improve demand management. AI, for example, can analyze usage data and predict peaks in supply and demand.

Customer experience and engagement

AI facilitates segmentation while micro-targeting makes it easier to forecast individual activities. The energy industry is able to provide new customer services.

Asset optimization and predictive maintenance

AI algorithms are able to monitor the condition of assets for predictive maintenance in real time. The energy industry is able to optimize its asset management.

Operations and outage management

To maintain a reliable grid, AI algorithms can automatically detect and address vulnerabilities in self-healing networks. The grid is able to reconnect with other parts automatically.

Revenue protection and security

AI algorithms can help the energy industry to secure its grids by analyzing usage patterns, consumption profiles and other customer data to avoid energy theft and other external attacks.

$19.1 billion:

Worldwide spending on cognitive and artificial intelligence systems by 2018[1]

$52.2 billion:

Worldwide spending on cognitive and artificial intelligence systems by 2021[2]

1.8 million:

Number of jobs will be replaced by AI in 2020[3]

2.3 million:

Number of jobs AI will create by 2020[4]

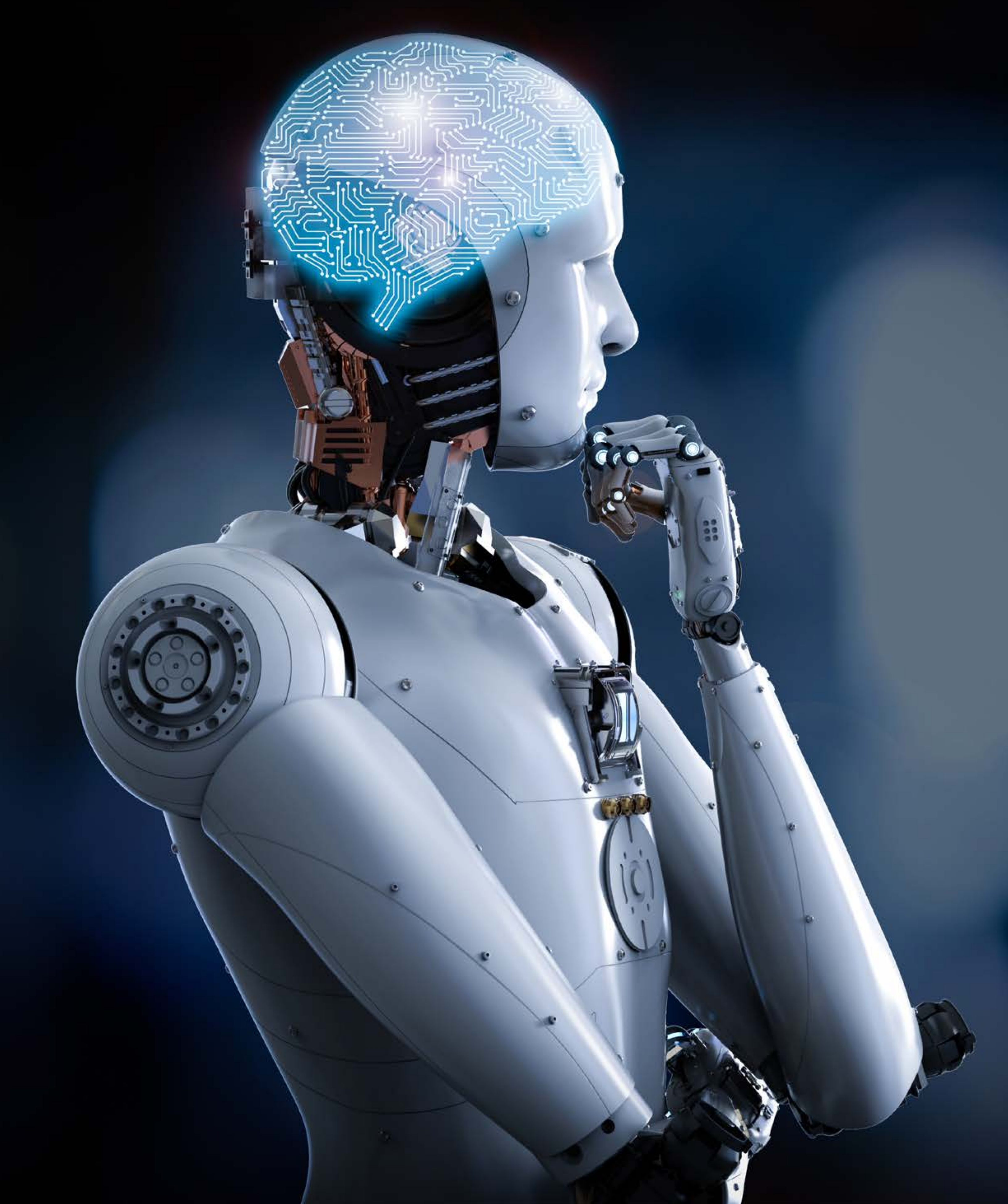
83%

of top European utilities executives consider artificial intelligence a high to medium priority for their business[5]

5%

of them have defined a KI strategy, clear related goals and an implementation roadmap[5]

Source: 1 https://www.idc.com/getdoc.jsp?containerId=prUS43662418 2 https://www.idc.com/getdoc.jsp?containerId=prUS43662418 3 https://www.gartner.com/newsroom/id/3837763 4 https://www.gartner.com/newsroom/id/3837763 5 Roland Berger GmbH: Think:Act – Artificial intelligence: A smart move for utilities, 2018. https://www.rolandberger.com



the power of intelligence

how artificial intelligence will transform the energy sector

Artificial intelligence used to be not much more than a buzzword, but with recent advances in technology and network capabilities, AI and its applications are starting to fundamentally change the way we do business and will continue to do so in coming years, including the energy industry.

A number of high-profile examples in different industries are highlighting the disruptive potential of AI-controlled systems. Caterpillar, the US heavyweight in industrial and mining vehicles, has been developing autonomous driving systems for over 30 years and recently signed a new deal to install the technology in around a hundred mining trucks in Australia. Amazon's recommendation function has used machine learning systems for years. The technology recently received greater exposure when Amazon decided to leverage their expertise by offering machine learning computing as a service on their Amazon Web Services (AWS) platform.

Machine learning is a foundation on which natural language recognition systems are built, with examples on the market from multiple providers. In 2017, Google announced the creation of a new division, devoted solely to developing AI, both its technology and its implementation into new and innovative use cases. Self-driving cars are making their way onto the streets, and AI in finance and trading is making markets more efficient. But what does AI mean for the energy sector? What will this technology disruption of the market mean for utilities, and consumers? And what opportunities and threats lie ahead, as AI enters more areas of day-to-day business?

The opportunities and potential for disruption are significant in the energy industry, and enterprises of all sizes need to start thinking about what AI will mean for them and their business in the coming years. AI has the potential to change many aspects of our business, from internal processes and corporate structure to customer service and communication. The first step is to understand the technology and its potential to change our industry.

An intelligent, efficient system

The most widespread form of AI in use today is a technology known as machine learning. Using huge data sets, a machine learning system can be trained to categorize objects, to recognize patterns and correlations, and can execute a number of other problem-solving tasks.

The systems available for implementation today, including the headline-grabbing technologies, artificial neural nets and deep learning networks, are what is known as “narrow AI.” In other words, they are systems designed to solve a particular problem or analyze a specific question. They still fall short of what is called “general AI” or a system that would be capable of learning new topics and solving problems in different areas. For the moment, only human and animal minds are capable of this kind of flexibility.

But even in the limited field of “narrow AI,” the available systems can hugely outperform human problem solving. Their strength is that they can find patterns in mountains of data that are not visible to the human eye. These patterns can be used to make predictions and guide decisions, with wide-ranging benefits also in the energy industry.

Predictive analytics in smart grids

Predictive maintenance and predictive analytics are gaining further focus in utilities’ operations. Minimizing the negative impact of mechanical failure, for example, is far easier and cheaper if it is done before the issue occurs – providing it can be foreseen. Here, AI provides a huge potential. (see also page 14: “Making the smart grid work for everyone”). Whether it’s a field of wind turbines or a network of cables and substations making up a local energy grid, modern facilities generate and collect a huge volume of data. Machine learning algorithms can quickly learn the normal operational parameters and behavior for each individual subsystem from this data. These norms can then be applied to real-time incoming data from the system, and instantly flag any system element that is behaving unusually. It means the difference between a minor fix now and a major and expensive repair down the line. The more data these systems have access to, the better their predictions will become. Instead of just flagging a single grid substation as acting unusually, the system can recommend checking a particular component, based on data from past technical problems.

The future could involve even greater automation of data collection and decision-making processes: predictive analytics could autonomously dispatch flying drones to more closely investigate damage to wind turbines, place orders for replacement components or book maintenance crews. This level of intelligent analytics has the potential to reduce costs in a number of ways: by reducing both operation and maintenance costs; by improving efficiency at both power plant and network level; by reducing unforeseen and unplanned outages and resulting downtime; and by extending the operational lifetime of hardware assets. According to the 2017 Digitalization and Energy Report[1] from the International Energy Agency, this could bring savings of around 5% of total annual generation costs, with benefits for both suppliers and consumers alike.

A second AI use case is in yield optimization, which maximizes production efficiency by making real-time adjustments to generation technology. A study from General Electric (GE) predicts a 20% increase in production from preexisting wind farms, purely based on yield optimization[2].

Managing supply and demand

AI technology is not useful just at the lower level of individual devices and installations. When the power of AI is applied to the huge volume of data collected from a regional or national supply grid, it enables a number of new, efficient options. Some interesting pilot projects are already under way. In the UK, Google’s Deep Mind is working with the utility provider National Grid to implement sophisticated load forecasting[3]. The solution will analyze usage data and predict peaks in supply and demand. Current estimates indicate it will reduce energy usage by 10%[4]. In situations where load can be flexibly managed, machine learning can be used to automate and improve demand management. In the UK alone, it is estimated that this could free up as much as six gigawatts[4] of demand-side flexibility which could be shifted during the evening peak, without having an impact on consumers. Put in context, this is around 10%[4] of peak winter demand.

End-user functionality and benefits

Speech recognition technology is not just for taking song requests using Alexa voice commands. Virtual agents can bring automation to the call center experience in the same way that chatbots have for automated text queries. With lower costs for the business and no more holding the line for the consumer, the benefits on both sides are clear.

AI can also be used to better understand individual energy customers by analyzing their consumption data. This data can produce insights into consumers, their behavior, and their likes and dislikes, for example, regarding attitudes towards renewables, to enable utilities to offer custom pricing packages for different sectors of the market. This is where AI implementation can go beyond what is currently possible with smart metering. AI can interpret user data, so that utilities not

Sources: 1 https://www.iea.org/digital/ 2 https://www.ge.com/renewableenergy/stories/meet-the-digital-wind-farm
3 https://www.businessinsider.de/google-deepmind-wants-to-cut-ten-percent-off-entire-uk-energy-bill-using-artificial-intelligence-2017-3?r=UK&IR=T
4 https://www.digitalistmag.com/digital-economy/2018/05/17/10-ways-utility-companies-can-use-artificial-intelligence-machine-learning-06167501

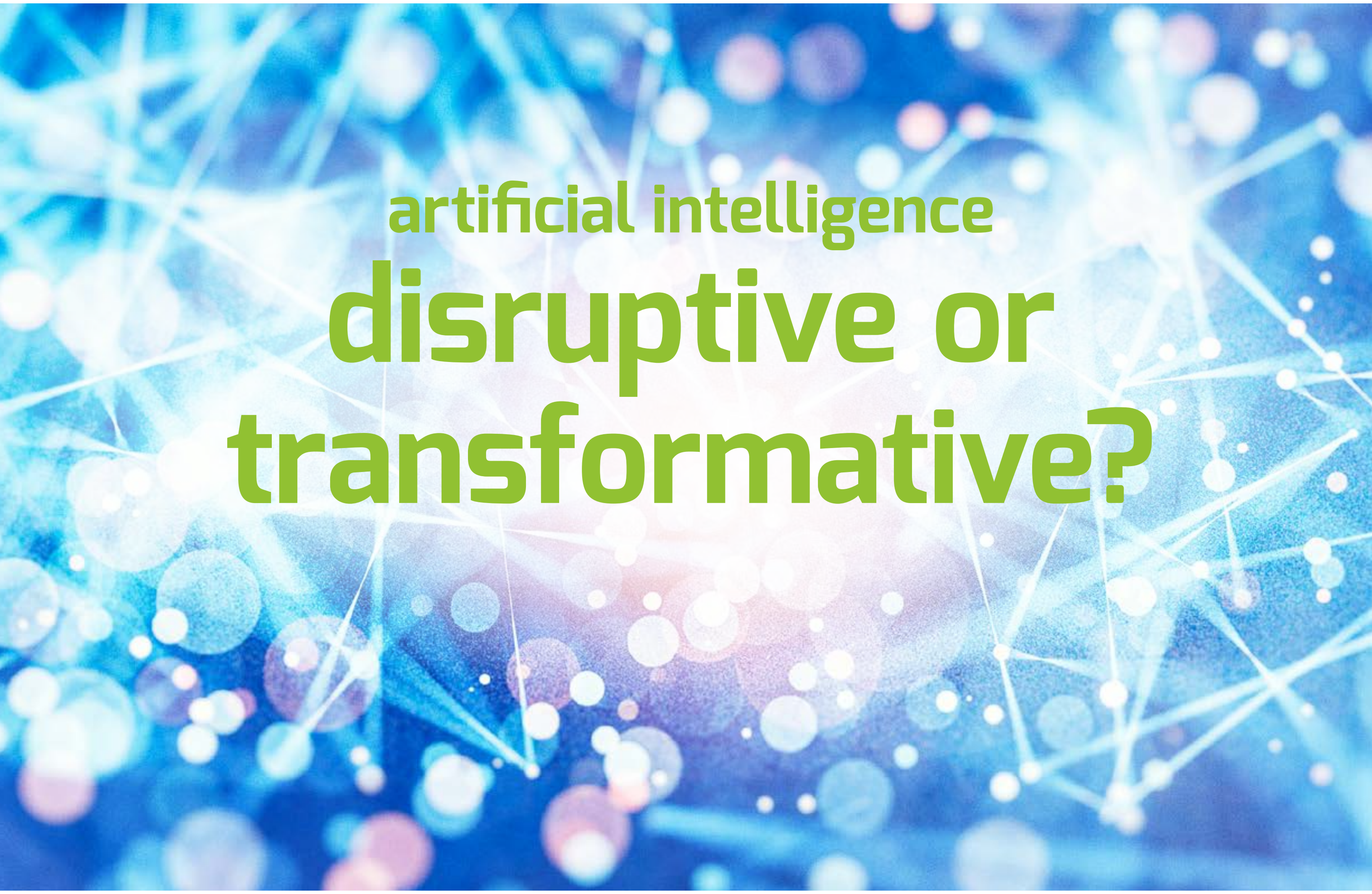
only monitor consumption, but predict the development of particular consumption profiles. Utilities can leverage these insights to proactively offer new services – find out more in our article on AMI disaggregation on page 18.

Data to power the future of energy

The power of AI opens up some exciting new opportunities for the future of the energy industry, and much of this is built on smart grids. These new applications have two main requirements: input and output, both provided by smart grid infrastructure. First, AI systems need to be fed with huge volumes of data. This means that a grid using smart devices and sensors that collect a range of information regarding its own behavior is a prerequisite for taking advantage of the power of AI. Second, utilities can only benefit from the power of AI if they can allow the system a degree of autonomy, so the machine learning algorithm can make decisions based on the data it receives and, as an output, automatically make adjustments in different areas of the grid. In order to do this, modern, smart devices with instant connectivity are a must. This is the long-term value of a smart grid. Smart meters with advanced communication technology feed data constantly into the analytics systems, and in return can be controlled at a distance to maximize efficiency and productivity.

Planning for the future

So what should firms in the energy industry do, to fully benefit from the AI boom and ensure they don't lose out? The first step is to welcome the change, and invest time and resources in developing AI capabilities. Companies need to begin implementing their own AI-driven projects and therefore build up expertise in-house or rely on external partners. The experience gained from even a small, in-house AI optimization might mean the difference when considering the next strategic development. The threat in this revolution is clear: many tech giants are ahead of the competition when it comes to AI development and implementation, and these skills are transferrable across business domains. However, the opportunities that AI integration opens up in the energy sector are only limited at the moment. Energy industry players that forge new use cases and implement high-tech, streamlined solutions harnessing the power of AI will do more than just benefit from the savings and efficiency boost offered by reactive systems. They will be in a unique position to take the next step, to shape the future of the industry. Beyond the smart grid, to smart energy.



artificial intelligence
disruptive or transformative?

Hans Fugers

Hans Fugers has been a technology trendwatcher for many years. Having worked for Alliander for ten years, Hans Fugers is a member of their R&D team with a focus on “digitization demonstration projects” in the fields of artificial intelligence, robotics, and digital twins.

Tobias von Haslingen

A forward-thinking visionary, Tobias von Haslingen looks back on a long history of exploring neural networks and disruptive technologies like optical character and voice recognition as well as implementing machine learning systems. Today he provides consultation services regarding AI and ML, helping organizations in the adoption and application of these technologies.

Donnacha Daly

As VP Business Innovation at Landis+Gyr, Donnacha Daly focuses on strategy, innovation and corporate development. He is a seasoned expert in the fields of signal processing, digital communications, algorithms and data science. He has applied these skills in diverse industries, including energy management, telecommunications, semiconductors, and financial asset management.

Artificial intelligence (AI) is expected to have a significant impact on the energy sector. In this issue's round table, we discuss the status quo and future perspectives with experts from an energy company, a solution provider and a consultancy. Hans Fugers is Strategy Consultant Advanced Technology at the Dutch DSO Alliander. Tobias von Haslingen is a consultant specialized in AI and machine learning. Donnacha Daly is Vice President Business Innovation at Landis+Gyr.

AI and machine learning – are these topics still science fiction or are they already business reality in the energy sector?

Hans Fugers: Cognitive systems can be more tangible than you'd expect. We are developing them as an up-front solution to optimize and schedule our field work. In the run-up to a smart meter installation, for example, we ask our customers to take photos of the metering environments and evaluate them using an automated process to estimate the workload in each case. This object recognition facilitates planning and allows installation to be completed in a single session, even under difficult conditions. In a second application, our subcontractors take before-and-after pictures to document the extra work they did for the invoices they send us. Checking all these pictures would be very time-consuming and involve errors, so instead we monitor random samples automatically. And there are many other possible use cases involving business information and grid analytics.

"Cognitive systems can be more tangible than you'd expect."
Hans Fugers

Tobias von Haslingen: ... as well as billing and new services on the customer side. Most of these examples show how artificial intelligence is already shaping business processes and operations. But not all companies are aware that they are already using AI technology or machine learning systems. Spam filters, for instance, use machine learning technology, and they have become a matter of course for most of us. For more than 15 years, most utilities have paid for services that are based on AI systems. Optical character recognition (OCR) engines deployed for invoice recognition for instance have been using machine learning algorithms a long time. But only few have developed a coherent AI strategy.

Donnacha Daly: When we talk about AI today, we're talking about "narrow AI" – artificial intelligence handling a single task type or domain-specific problem.

"Data capture, storage and processing put AI on steroids."
Donnacha Daly

"Artificial general intelligence (AGI)" which emulates human intelligence is still elusive, at least for the time being. In the sense of narrow AI, there are already applications all around us, the principles of AI and machine learning haven't really changed that much since they were first introduced decades ago. But we're at a turning point in terms of data capture, data storage and data processing, which puts AI on steroids. Cloud environments can now handle huge data volumes efficiently and enable cost-effective AI solutions that will not only support utility operations but also enable better quality customer services. Here is a real, working example: in our partnership with Grid4C in Asia-Pacific, we are already demonstrating the benefits of AI for consumer analytics, and reduction of customer churn (see page 18).

In general terms, what is the potential of AI in the energy sector?

Tobias von Haslingen: It's difficult to predict the whole potential of AGI solutions, because they will enable totally new types of business ideas and applications that we cannot even imagine yet. For the energy sector, smart grids are among the most obvious use cases, but others will follow.

Donnacha Daly: AI has real potential whenever large enough data sets can be captured to effectively train the underlying machine learning algorithms. On the grid operation side, the transition from classic grid monitoring at the substation level to full residential smart metering has scaled available data volumes and resolution by orders of magnitude in terms of what the utility can leverage. On the retail and generation side, traders have always been at the forefront of technology adoption, making us of whatever gives an edge. We have had many conversations with energy companies looking to apply AI and machine learning for the optimal dispatch of assets. Often, the challenge for these types of companies is not the artificial intelligence – rather it's the connectivity and control of low voltage grid assets, and intelligence at the grid-edge. This is the Landis+Gyr sweet spot, it makes us really optimistic about the future landscape of added value applications which can be built on utility IoT.

Hans Fugers: DSOs generate value from data by using predictive asset lifecycle models and network optimization. If we succeed in integrating AI technologies into an analytics environment, this will create vast opportunities. To come back to the object recognition mentioned earlier – there's also huge potential in this area. With this material we can provide assistance, spot dangerous situations, update knowledge on local situation of assets.

What are the biggest challenges for DSOs, technology providers and utilities?

Tobias von Haslingen: Data collection is a significant bottleneck for companies trying to create or increase the performance of AI systems. The technology already exists, both in terms of hardware and software, but it has not been installed everywhere. For example, many countries have still not installed smart meters and they simply don't have the data. That's why many utilities are not there yet.

Donnacha Daly: The low-hanging fruits for AI are mainly open-loop, or human-in-the-loop applications such as predictive analytics, asset management, fault detection etc. It's when you move to full closed-loop automation, that you face the bigger challenges. Much of the "subject matter expertise" remains with a generation of seasoned utility professionals, and has resisted codification for closed-loop algorithmic grid management. However, it must be expected that even some of the most intractable edge cases will fall to the advances of AI as these utility applications mature.

Hans Fugers: Human resources is another bottleneck. How many people are familiar with AI? The tools are there, but the professionals to harness these tools are rare. The question is: how will AI help our professionals by taking over repetitive administrative tasks, which do not require the skills of a human expert and make them more productive and happy at the same time?

How will the deployment of AI affect the roles of the different players, will it disrupt our industry and business models?

Hans Fugers: Companies like Google, Apple and Microsoft are establishing footholds in homes, and that's a serious threat to the business models of retailers. For DSOs, things are different. AI is less disruptive for asset-intensive industries. Retailers have to know what's going on in the homes of their customers to create new products and services, and the network operators who own the meters could provide the respective services, enabling them to increase customer engagement, if the regulators go along with this.

Tobias von Haslingen: AI is a disruptive technology. If you haven't worked with AI, you have a hard time understanding it. That's why even saturated markets are seeing the rise of new players who utilize data in new ways. In the digital era, Apple wiped out Nokia, and there will be an "Uber" disrupting the energy sector just like the taxi industry if utilities don't act now. Utilities and DSOs alike have to renew themselves constantly to stay on the edge. It's similar to what happened at the beginning of the Internet era 25 years ago, and companies that adapt intelligently will have a huge advantage. Technology and service providers like Landis+Gyr have the potential to be an important driver for analytics, machine learning and artificial intelligence. They utilize big data and create value for their customers.

"If you haven't worked with AI, you have a hard time understanding it."
Tobias von Haslingen

Donnacha Daly: Our industry faces disruption with or without AI. We have already seen how climate change has driven a backlash against hydrocarbon fuel sources, which in turn has driven a rise in intermittent renewable generation, storage technologies and electric vehicles, right across the globe. There is every reason to believe that the next decade will see an acceleration of this trend, as well as policy and regulatory-driven incentives to experiment with new business models for grid resilience, security of supply and transactive energy. Artificial intelligence will play its role in this, and like all new technology adoptions, there will be use cases and applications which cannot be foreseen today. Needless to say, this is an exciting time for technology professionals and entrepreneurs in our industry.

feeding the brain

reliable connectivity vital for strong AI and IoT growth

The foundation of AI lies in data. The latest communication technologies provide data more reliably and efficiently than ever. By introducing Narrow Band Internet of Things – NB-IoT – for advanced metering infrastructure (AMI) in the Nordics, Landis+Gyr and Telia aim to create a new innovation platform for the energy sector.

NB-IoT is a low-power wide-area network (LPWAN) technology based on the existing 4G/LTE mobile network and optimized for IoT communication. With broad coverage and permitting a long battery life in connected devices, it's a perfect match for smart energy metering – enabling cost efficient, reliable and robust data transfer from smart energy meters to utility systems. NB-IoT cost-efficiently and reliably advances the digitalization of the grid by allowing the connection of a massive number of different devices into a single network. As a technology standardized by 3GPP that unites several telecommunications standard development organizations, it is commonly seen as the true enabler of Internet of Things.

"I see significant potential for NB-IoT in the energy business, not only as an efficient media to transfer data, but also as an enabler of IoT and AI," says Kristofer Ågren, Head of Data Insights at Division X in Telia.

Connectivity, AI and IoT

Artificial intelligence involves analyzing, learning, adapting and problem solving to improve equipment and technological performance. AI has developed rapidly over recent years, enabled by massive increases in data and computer processing power, lower component prices and significant business start-up activity in this field. "Much faster parallel computing is exactly what you need to train the algorithms, the deep neural networks, in AI," says Kristofer Ågren.

AI is a core technology driving an even smarter IoT world, and for this to work, efficient, ubiquitous and secure connections are needed. Connectivity is key: the data quality has to be correct and consistent, understandable and useful from the start.

"AI is the brain or the automation framework, and IoT the arms and legs," says Ågren. "These limbs are the data generator, sensor, mechanism, wiring and enabler that carry out actions decided by the brain. AI thrives on thinking about and making sense of many data sources and vast data streams, which IoT provides. All this data trains the algorithms in AI, increasing technological performance and efficiency."

Fueling development with smart metering data

When introducing high-profile innovations based on AI, the importance of robust and reliable streams of data is often overshadowed. Smart meters already deliver large amounts of data to energy utilities, providing potential for a wide range of applications. As the volume of smart endpoints in the field increases, NB-IoT responds to the need for increased coverage and efficiency, opening the door for new uses. It can be used in various geographical environments, operating reliably in different field conditions.

Furthermore, as they represent a pure point-to-point technology, NB-IoT devices are completely independent of other devices in the field. Since NB-IoT doesn't require any data concentrators or gateway devices, its signal reception and therefore service levels remain stable, which also reduces maintenance costs for the smart metering operator.

A revolution in the energy sector

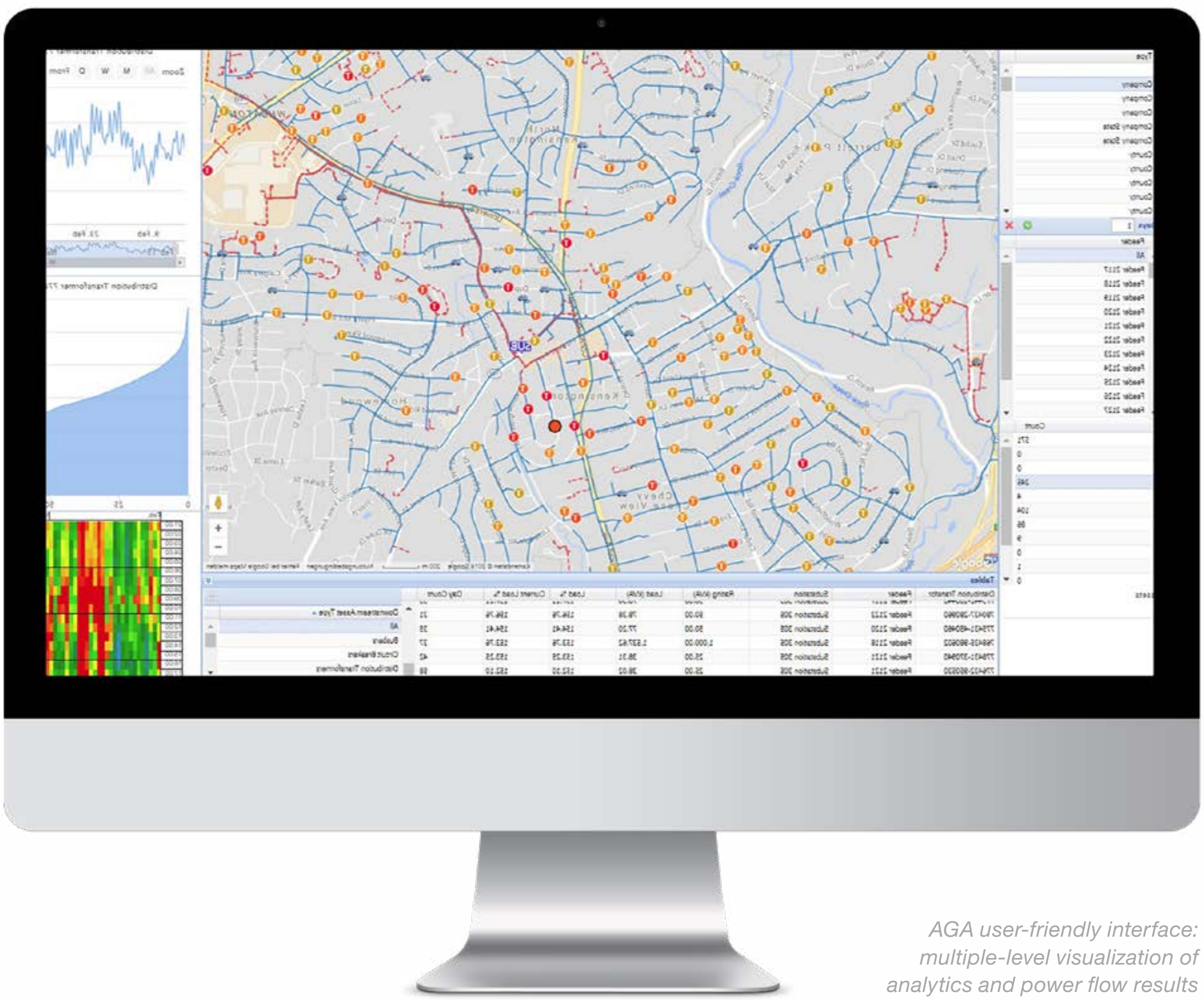
AI is widely and increasingly used for a number of industries. From gaming and manufacturing, to banking, health, e-commerce and transport. There are also significant opportunities in the energy sector: "Everyone needs energy, it's an area in which connectivity fits in well, and where AI can reign," says Ågren. IoT-based actions include switching on heating, lighting, air conditioning or the oven. Empowered by AI, IoT integrates the physical and digital worlds, enables devices to collect and share data and to interact – and all without the need for human input or intervention. Ågren continues: "We've had industrial revolutions before, AI is part of the fourth industrial revolution based on digitalization, and NB-IoT is helping to pave the way."

Kristofer Ågren
Kristofer Ågren is Head of Data Insights at Division X in Telia, the largest telecoms company in Sweden and fifth largest in Europe. Before joining Telia in January 2018, he held management roles in software architecture, data analytics and technology consulting in companies in Europe and the US.

Landis+Gyr continuously develops its portfolio in AMI communications technologies. The introduction of an NB-IoT communicating solution in the Nordics, one of the most connected regions in the world, is a demonstration of company's capabilities to take benefit of the latest advancements in the field of communication technologies.

making the smart grid work for everyone

using advanced grid analytics to derive value from data



AGA user-friendly interface: multiple-level visualization of analytics and power flow results

Some technologies quickly become a buzzword, filling headlines around the world. Big data and artificial intelligence are striking examples of this. However, it is the solutions based on these technologies that have the biggest impact on an industry.

While the media has continuously reported on the disruptive power of AI, one tends to overlook other parts of the information ecosystem that need to run smoothly in order to provide AI algorithms with the data needed to generate actionable insights. Data analytics systems like Landis+Gyr's Advanced Grid Analytics (AGA) form the backbone of this information ecosystem, bringing together data from multiple sources, both historical and in real time, and making it available to drive better strategic decision-making in grid operation and asset management.

Smarter asset management

The decisions that utilities make on a day-to-day basis often involve asset management. Installing new grid assets and repairing or replacing old components are major investments, and the consequences of getting these decisions wrong can be expensive. "Utilities generally have multiple business goals," says Soorya Kuloor, Practice Director Distribution Operations at Landis+Gyr. "These include safety, reliability, and quality. Asset management plays a huge role in this – and utilities typically own a lot of assets." Traditionally, grid assets were placed in the field when needed and replaced when they broke down. Utilities used to make decisions on asset repair or replacement based on discussion, experience, and common sense. Considering new challenges, such as distributed energy resources integration, that isn't going to work anymore. The future will require data-driven operation as well as automation. By reducing downtimes in the network (proactive maintenance) or even acting before the failure occurs (predictive maintenance), utilities can improve supply quality significantly and save costs.

In order to implement a truly data-driven asset management strategy, a utility needs systems that make it possible to both visualize their distribution system and run asset management scenarios. An example of this is the simulation of adding new grid components or the effects of the failure of key assets. These scenarios are made as realistic as possible by using high-level granular data derived from actual system conditions. Utilities can then use the results of these analyses to develop, test, and justify asset management projects. Landis+Gyr Advanced Grid Analytics merges the data from geographical information systems (GIS) with operational data from smart meters and other sensors to allow the utility to geospatially visualize and analyze asset performance in the field.

To see how this works, let's take a look at an example from the USA. Pepco Holdings Inc. (PHI) were the first firm in the US to deploy an enterprise-wide, physics-based grid analytics platform when they installed a Landis+Gyr solution in 2014. The platform includes different analytics applications for visualization, planning and real-time operational analytics support. The analytics installed allowed PHI to improve analysis, prediction, optimization and decision-making capabilities. This included managing network assets, load balancing, support for volt/VAR optimization, reliability, and automated switch placement. This project was made possible by the ongoing collaboration that had already seen millions of AMI assets installed in PHI's grid.

"In Europe, utilities are at the beginning of this cycle," says Kuloor. "They're still figuring out what can and can't be done, and this is where AGA can help. But there's still a lot more to do and a lot more that can be done."

Data democracy

Grid data doesn't just come from smart meters. There are also transformer sensors and sensors in the power lines, as well as sensors embedded in the network devices themselves. The number of these sensors is continuously growing – with the increasing installation of solar panels and batteries, all of which carry sensors generating data for the system.

Soorya Kuloor
Practice Director Distribution Operations at Landis+Gyr

It's not only AMI data that can be turned into actionable insights, however. Historical data that was collected for diverse purposes can be fed into the AGA system and analyzed to identify potential improvements. Utilities typically have multiple back-end systems, each one collecting data for a specific purpose: geoinformation systems for asset data, outage management systems for historical outage details as well as (advanced) distribution and SCADA systems to handle real-time data. Since the introduction of AMI, customer information systems collect detailed data on customer consumption, premise voltages and power quality. By bringing all this data together in one system, enterprise-wide solutions can be identified that go beyond what each data silo is currently interested in. It is a democratization of data that allows managers more detailed insights into what is happening in all of the different business areas.

Turning data into action

But how does this system work in the real environment of a utility? "There are four stages to the analytics process," says Kuloor. First, visualization: maps, network grids, charts and graphs allow the huge volume of collected data to be presented in a comprehensible way. Geographical areas with poor supply reliability indices can be identified, or assets with a high risk of failure. Second, prediction: based on historical performance data, what is going to happen to this part of the system in the next six days or six months? Machine learning models are trained with historical network data and can list potential outcomes as well as calculate the probabilities of these events.

This information then provides the background for the third stage: simulation. Technicians can assess the future impact of replacing network assets or installing entirely new systems, or the impact of changes on the demand side. How would the network react if this particular substation failed? What would happen to the grid if e-Mobility usage reached 20% of the total power consumption? What would be the impact of another 5,000 homes installing PV? Possible scenarios can be realistically simulated, using known network data and operational parameters, giving the grid managers a better idea of what the impact of any possible actions might be.

This leads to the fourth and final stage: optimization. Actions are undertaken to improve the grid's functionality, in line with the technical data delivered from stages one to three, in addition to constraints from the business or regulatory side as well as broader corporate goals. The results of the actions can be visualized, to assess how successful the optimization was, and the entire cycle begins again. It is an iterative process that delivers constant improvements and helps to avoid nasty surprises from the portfolio of assets in the field.

Once the system is up and running, it will be possible to determine which types of network decisions should be automated. Within preset parameters, algorithms can be given authorization to directly adjust network settings, in order to react quickly to rapidly developing events. "These systems will never be 100% automated," says Kuloor, "but the goal is to automate as much as reasonable." That's why it's so important to carefully select the tasks that the computer will be responsible for: delegating simple, repetitive tasks or some reactions that can be predefined based on a calculation, and allowing technicians more time to focus on the kind of jobs that cannot be delegated to a machine. "If we can automate jobs like data collection and integration – that would be a big boost in productivity for utilities."

Implementing cutting-edge solutions

Given the stakes, it is vital that utilities choose the right system for their business needs. So, what is the competitive edge to Landis+Gyr's Advanced Grid Analytics? "There are a lot of good solutions in the market that take meter data and focus on the customer," says Kuloor, "with functions like customer segmentation, energy efficiency and revenue protection. AGA complements them with a strong focus on the grid side, and the day-to-day operations of a utility, more specifically: how to best use analytics for distribution operations. Managing assets, planning the system,figuring out ways to reduce outages, and minimizing the impact of outages that occur."

> *"Utilities generally have multiple business goals. These include safety, reliability, and quality. Asset management plays a huge role in this – and utilities typically own a lot of assets."*
>
> **Soorya Kuloor, Practice Director Distribution Operations at Landis+Gyr**

Having the right analytics system is the foundation that the advanced technologies of the future will be built on. However, a system of this size and complexity is a long way from plug-and-play. There are a number of challenges that utilities will have to face in order to gain the full benefits of a system like this.

Integration

First, the analytics suite needs to be integrated with all other data systems across the company, and this means making decisions about how to adapt the different standards found in individual data silos to best make the data available to analytics procedures. As each historical system was built to serve a particular need, each collects data in its own particular way. A standard implementation mechanism needs to be agreed and implemented in each data migration to ensure compatibility.

Prioritization

When you have a shiny new tool, you might be tempted to use it in every situation, but the first application that springs to mind might not be the most impactful. Careful thought is needed to choose how and where to implement the insights from grid analytics. After all, there are an almost limitless number of use cases that could benefit from the analytics approach, but utilities need to choose a small number of high-impact applications to start with. These will quickly provide demonstration of the system's power, and also give the technical team invaluable experience in leveraging this new technology to provide actionable insights. As time goes on, analytics can be applied to a growing number of use cases, but it is vital to remain focused in the initial stages of implementation to make best use of business and human resources.

Data care

To put it simply, the insights gained from analytics software are only as good as the data you put in. "If they want to take advantage of the full power of analytics, utilities need to become a lot more diligent in the way they keep track of data," says Kuloor. "It needs to be clean and up to date." And this is not a one-off task, but a change in behavior and an ongoing commitment to maintaining data quality over the long term.

The bottom line

Advanced Grid Analytics is the next logical step in the process of modernizing grid architecture, following the installation of smart meters. And the two steps both reinforce each other: just as AMI provides the data and remote-control capabilities needed to implement AGA, successful analytics use cases show a demonstrable return on investment in smart meter installation. "AGA proves the business case of installing smart meters in the grids of utilities," says Kuloor. Firms can point to all the different areas where savings are made, using the data they collect from the new hardware. "If I'm a utility provider, suddenly there's a huge pool of data on individual customer consumption or generation, and AGA can be used as a tool to derive value from this data by helping me to run my system better. It's a solution that makes the smart grid valuable for everyone involved, from the distributor to the consumer, and the regulators as well."

advanced grid analytics – making smart use of smart meter data

Ifigeneia Stefanidou, Innovation and Key Market Manager at Landis+Gyr, explains the multifaceted benefits of analytics.

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Landis+Gyr has partnered with US-based Grid4C to provide advanced AI and machine learning solutions for the energy sector. A joint pilot project in Australia has already shown promising results. In our interview, Shane Fay, Senior Vice President Global Sales at Grid4C, talks about how utilities can utilize these solutions to leverage their AMI data in a variety of business areas.

Grid4C empowers all energy value chain participants by utilizing advanced machine learning capabilities to deliver accurate, granular predictions, which are crucial for tackling the rising challenges of today's energy industry. Shane Fay, Senior Vice President Global Sales at Grid4C, is leading the company's global sales efforts.

***pathway:** How can AI and machine learning help improve business processes of utilities?*

Shane Fay: In our partnership, Landis+Gyr and Grid4C leverage AI and machine learning to enable energy providers to maximize business value out of smart meter data and IoT devices. We deliver accurate, granular operational and customer-related predictions to improve operational planning and load forecasting, reduce peak demand, increase energy savings and optimize demand response (DR). We also help tackle challenges like distributed energy resources (DER) integration, customer retention and customer engagement.

***pathway:** What are the key areas of Grid4C's predictive operational and customer analytics – and which insights do they provide?*

Shane Fay: Grid4C's solutions focus on three areas: customer-facing applications that help businesses and consumers not only to save money but also predict problems with the appliances they rely on, predictive customer analytics that facilitate segmentation and micro-targeting, and predictive operational analytics that predict grid asset failure, and optimize the integration and coordination of solar, energy storage and electric vehicles.

The AI engine uses smart meter and IoT data to model each meter and endpoint and predict its individual behavior. The models disaggregate and predict usage for appliances behind the meter and are aggregated to deliver predictions for grid assets. By building predictions from the most granular level up, the core technology drives applications ranging from forecasting and optimization of distributed energy resources, to predicting, detecting, and diagnosing faults and inefficiencies for grid assets and home appliances, without the need for hardware or sensor installations.

***pathway:** How can this information be monetized?*

Shane Fay: The insights that our AI engine are able to extract from smart meter reads enable utilities to target offerings very precisely. In compliance with data protection legislation, we identify customers likely to churn and customers likely to adopt solar, purchase electric vehicles, or participate in other energy efficiency or marketing offerings.

Another example of how utilities can generate new revenue streams is by monetizing the unique capability to predict, detect and diagnose faulty appliances within the home using AMI reads only. This enables utilities to provide new value added service offerings

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for residential consumers, which alert customers when they have faulty or inefficient home appliances, quantify the costs of the appliance inefficiency, and guide them to buy relevant products and services.

pathway: *How is the solution implemented into a utility's process and system environment?*

Shane Fay: We offer plug and play solutions, often needing less than two months to deploy them at scale. Customers can either use our displays and portals for a utility-branded experience, or opt for Data Science as a Service (DSaaS). In that case, we receive smart meter data and deliver the models and insights back to the utility to be displayed on their own screens or products.

pathway: *Briefly: who should take advanced AI and machine learning solutions into consideration?*

Shane Fay: Utilities and retailers who are interested in increasing revenues, maximizing profitability, enhancing customer satisfaction, offering value add services to their customers, or extending the value of their AMI investments are perfect candidates for our offerings.

pathway: *Please share what the future looks like and how Landis+Gyr and Grid4C are aligned to deliver value to utility clients.*

Shane Fay: The key trends of the industry are decentralization, electrification of private transport, increasing competition, growing intelligence at the edge of the grid as well as the integration of multiple products and services in connected homes. All of these will enable and require granular, accurate forecasts of energy consumption and production based on metering data. Landis+Gyr and Grid4C have the right solutions to maximize value for utility clients in the future.

in a nutshell: IoT predictive analytics

Landis+Gyr and Grid4C offer a complete suite of advanced tools for predictive operational, customer and home analytics. Machine learning and metering data are used to generate revenue streams, meet energy efficiency goals and to strengthen the market position in the highly competitive retail market. The solution allows accurate, granular predictions based on normalized data sets, APIs and signed meter data and is now close to mass deployment. “The simplicity of being able to go mass market with only the meter data is a very attractive offering for retailers,” as Rodney Chaplin, General Manager Australia & New Zealand at Landis+Gyr, puts it.

In the course of the joint project, a major utility in Australia reports:

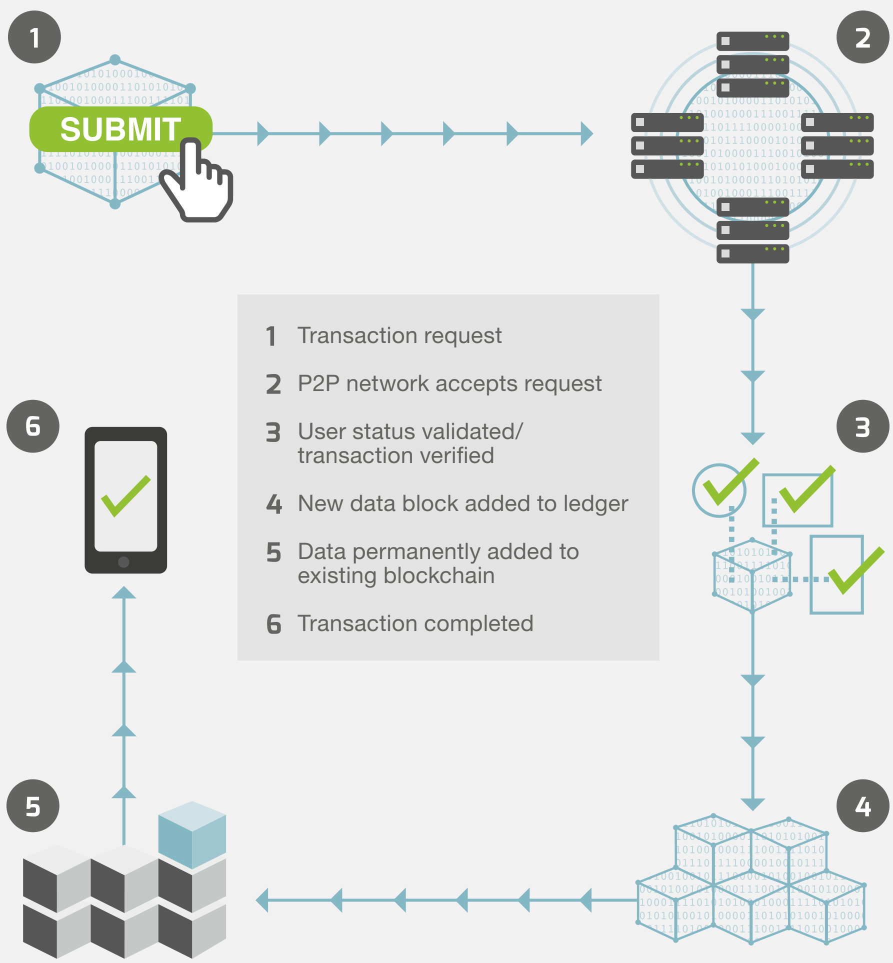
- a reduction of the customer churn rate from 10% (customers not receiving insights how to optimize their energy consumptions and the appliances they rely on) to 2.9% (customers receiving these insights),
- a ratio of 57% of customers participating in the trial who have filled in their home profile (in most cases with complete information about their home e.g., data that is suitable for personalized marketing).

blockchain energizes

AI is not the only technology development changing the energy branch. Another disrupting technology is blockchain. It is used to verify transactions by storing encrypted data in a distributed ledger format. Any transaction can be tracked to ensure transparency, security and immutability. Blockchain is already used in areas such as payments, insurance, voting, and protecting intellectual property, and it's also set to have an impact on energy markets.

While the term blockchain has only been widely known for the past two or three years, the original work already took place in the 90s and the first blockchain was conceptualized in 2008. Today, it's not only a leading technology platform for digital assets and peer-to-peer transactions, it's also underlying hundreds of cryptocurrencies such as Bitcoin.

the blockchain process



Consensus-based transactions

A blockchain is an expanding, cryptographically linked list of transactions, or blocks. Each block contains secure, unchangeable, trusted and encrypted data. Rather than using a central authority, data center and web server, a blockchain is a decentralized, distributed ledger that is collectively shared and managed by a peer-to-peer network.

All participants adhere to a consensus-based communication and validation protocol. In the case of cryptocurrency, everyone sees the same traceable, accurate and trackable cryptocurrency transactions, from the first to the last block, and all this ensures complete integrity. With its rule-based interaction and nondiscriminatory access to data, blockchain is set to have a major impact on energy trading, grid management and operations.

People power

Energy markets are changing dramatically. Consumers are switching energy suppliers to get the best price or green energy from renewable sources. Prosumers, who both produce and consume energy, are becoming more independent, investing in solar panels and wind turbine power generation, as well as energy storage and demand respond. Smart meters are used to track and optimize energy use and costs. Electric vehicles and charging stations can lead to grid strains. All of these developments require new ways of synchronizing market activities and trading.

Blockchain in the energy market

Blockchain-based applications:
- remove the need for a central authority or intermediary,
- streamline and automate processes,
- standardize formats,
- reduce the need for human administration and checks,
- speed up settlements,
- cut transaction costs.

electricity trading

These lower costs will help the many new energy market entrants to produce and trade electricity, even in relatively small quantities.

Blockchain transactions automatically incorporate timestamp and location information. They can also integrate certificate of origin and chain of custody information, letting consumers know the source of their energy. The technology is starting to play a role in the microgrids of electricity producers and users in self-contained areas such as campuses, apartment blocks and business parks. Here, blockchain-based smart contracts – self-executing computerized transaction protocols – between consumers and generators constantly assess electricity demand and supply and then automatically carry out and verify transactions between energy buyers and sellers. These applications are enabling prosumers to supply the surplus energy to their neighbors or, if connected, to the wider grid.

Although currently taking place on a small scale, there is huge potential for blockchain-enabled peer-to-peer and machine-to-machine (M2M) transactions on a larger scale, e.g., to maximize the transactional efficiency of virtual powerplants and to optimize electricity production and consumption.

Increased business agility

Utilities feel the need to become more proactive and agile in the new energy environment. Major energy companies are among the 43 participants in Ponton's Enerchain, for example, a pioneering platform for blockchain-based P2P wholesale energy trading. At a time when energy production and consumption are increasingly decentralized, P2P trading and trading environments such as Enerchain obviously affect the traditional utility model. On the other hand, energy companies can facilitate blockchain to increase the speed and security of their own operations, integrate smaller generators into highly reactive demand response programs and to synchronize the activities of their market partners. Utilities are experimenting with blockchain technology to exploit new opportunities in existing and emerging business areas.

There could be an even greater adaption of blockchain applications thanks to the Energy Web Foundation, a global nonprofit organization focused on accelerating blockchain across the energy sector. Its initiatives include creating common definitions and standards, and developing Energy Web (EW), an open-source, scalable blockchain application, which serves as a foundational, shared, digital infrastructure for the energy and blockchain community to build and run their solutions. Based on the widely used Ethereum blockchain development platform, EW is specifically designed for the energy sector's regulatory, operational and market needs.

The utilities are now starting to see blockchain as an opportunity rather than a threat. With their significant physical infrastructure, resources and expertise, they are well-positioned to help with designing and building microgrids. They can operate private, limited-access blockchain-based platforms to enable energy self-generation, storage and trading; and use electricity generated by prosumers to supplement their own energy production and thereby increase system resilience.

the rise of Crypto Valley Zug

Zug, home to the headquarters of Landis+Gyr and its Swiss organization, has turned into a global hub for crypto, blockchain, and distributed ledger technologies. More than 200 foundations, startups and companies like Ethereum, ConsenSys and Monetas form an ecosystem of innovation and entrepreneurship. The rise of "Crypto Valley Zug" is the result of a long-term strategy to create an ideal business environment in the city and the canton of Zug for the crypto and blockchain movement.

The city of Zug itself is a forerunner in terms of blockchain technology. As the first municipality in the world, Zug began an initiative accepting Bitcoin as payment for municipality services as early as 2016. Two years later, it conducted a blockchain-powered trial municipal vote for its citizens based on the digital ID system. The system itself launched in November 2017 as one of the first of its kind.

green news: all about energy

Hoover Dam to become energy store

The Hoover Dam on the Colorado River between Nevada and Arizona is one of the most impressive structures in the United States. Now the dam is to be used not only for energy generation, but also as a gigantic energy storage facility. The $3 billion project focuses on storing excess energy generated during the day in Californian photovoltaic plants to compensate for peak loads and stabilize the grid. The system works much like a hydroelectric power station: downstream, water is pumped into the water reservoir from a pump station powered by solar and wind energy via a pipeline that runs parallel to the riverbed. As it flows off the reservoir again, the water activates the power generators. A kilowatt hour stored in this way is not only ecological, but also more cost-effective than in a lithium-ion battery. The construction is to be completed by 2028.

Sweden meets green energy target much earlier

Sweden is one of the front-runners when it comes to promoting the energy transition process. By 2020, the country wants to increase its energy production from renewable sources to 28.4 TWh per year. 2018, this plan was adjusted to add another 18 TWh by 2030. Sweden reached the overall target already by the end of 2018 – much earlier than expected, mainly due to the increased energy production from approx. 4,000 wind turbines countrywide. This is an essential step towards their ambitious targets to generate all of the country's electricity from renewable sources by 2040.

tech giants focus on sustainability

Facebook is going green. At the end of August 2018, the tech giant promised to reduce its greenhouse gas emissions by 75 percent and to power its global operations completely with energy from renewable sources by the end of 2020.

As early as 2015, the global enterprise announced that it would supply 50 percent of its facilities with "green" electricity by 2018. This target has already been reached: one year ahead of schedule. Other tech giants are also committed to sustainability. In the long term, Amazon also wants to supply its locations with 100 percent renewable energy. To achieve this, it operates its own wind farm in Scurry County, Texas, for example, which produces 1 million MW annually.

Apple is following the same path. Not only is the company currently switching its headquarters in Cupertino, California, completely to solar power, but is also using solely "green" energy in its worldwide locations, offices, shops, co-located facilities and data centers. A 17 MW solar power plant is located on the roof of the company headquarters. The worldwide capacity of energy generation through Apple projects is 626 MW and is to be expanded to 1.4 GW.

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