Update of the European Data Market SMART 2016/0063

Story 5 – AI paving the way for the Cognitive Revolution across European Utilities

14th May 2019

Author(s)	Jean-François Segalotto; Giorgio Micheletti (IDC)
Deliverable	D 3.5 Quarterly Stories (Story 5)
Date of delivery	15th May 2019
Version	1.0
Addressee officer	Katalin IMREI Policy Officer European Commission - DG CONNECT Unit G1 – Data Policy & Innovation EUFO 1/178, L-2557 Luxembourg/Gasperich katalin.imrei@ec.europa.eu
Contract ref.	N. 30-CE-0835309/00-96

Table of contents

EXECUTIVE SUMMARY **5**

1. INTRODUCTION **6**

1.1 MAIN OBJECTIVES AND SCOPE 6

1.2 METHODOLOGY AND STRUCTURE 7

2 THE DATA-DRIVEN (R)EVOLUTION IN THE UTILITIES INDUSTRY **8**

2.1 FROM POLICY AMBITION TO INDUSTRY INNOVATION 8

2.2 TECHNOLOGY AND INDUSTRY DISRUPTIONS 8

2.3 ADDRESSING CHANGE WITH DATA AS A COMPASS 9

1.1.1 Putting Intelligence at the Center of Operations *9*

1.1.2 Living Up to Growing Customer Expectations with Data and Automation. *10*

1.1.3 Creating New Value from Data *11*

3. AI-DRIVEN UTILITIES ALREADY AT PLAY: APPLICATION AREAS AND CASE STUDIES **13**

3.1 A LOOK AT POPULAR AI USE CASE FAMILIES FROM A SURVEY PERSPECTIVE 13

3.2 A LOOK AT REAL-WORLD AI IMPLEMENTATIONS 14

3.2.1 Operating Model Transformation *14*

3.2.2 Customer Service Transformation *17*

3.2.3 New Revenue and Business Models *17*

4. CONCLUSIONS AND PRELIMINARY POLICY REMARKS **19**

Executive summary

Utilities face some of the strongest headwinds in their century-old history. Energy technology is changing how energy and resources are generated and consumed, reducing demand and making the energy system more complex and unpredictable. Digital technology has raised the bar for utilities customer service while at the same time lowering the sector's barriers to entry. The industry is determined to use data as a compass to address this change, leveraging data technology like analytics and artificial intelligence (AI) to excel in operations, improve customer satisfaction and create new revenue streams and business models. The EU's policy ambition in decarbonizing and unbundling the energy value chain and creating a competitive energy market has made European utilities among the most innovative in the world, and this extends to pioneering use of AI.

A 2018 IDC Energy Insights survey confirms that, while AI is still in its infancy, almost 40% of European utilities are already using or have immediate plans for the technology. Early adopters are using machine intelligence across a broad spectrum of processes, from customer service automation (28% of utilities are either using or plan to use AI for this, in the next 12 months) to predictive maintenance (25%), regulatory compliance (25%) and IT automation (24%).

The desk research and in-depth interviews carried out across the six case studies presented in this research confirm these findings, showing that AI is being successfully employed to improve or transform the organization's operating model, enhance the customer experience, and create new revenue streams and business models. Global services company Atos, for example, is using AI to improve the way utilities fight energy theft (which cost an estimated some €1.3 billion a year to the European gas sector alone). Using AI and automation, Atos customers analyzed in this report have managed to increase their ability to identify episodes of energy theft six-fold and reduce the operational cost of their entire revenue protection process by 75%. Enel Green Power, the renewables divisions of Italy-based energy utility Enel, provides another example of the use of AI to transform operations. The company is integrating real-time plant fault recognition technology onboard its maintenance drone fleet in North America, making inspections more efficient and reducing detection-to-repair from days to hour. A case study from E.ON offers further confirmation that asset operations and maintenance are a hotbed for AI. The company has developed analytical models to detect fault predictors for its medium voltage lines and combined these with a self-learning algorithm improving the accuracy of these predictions over time. The result was 100% to 200% better fault prediction after just nine months of use and training of the algorithm. The company estimates that shifting to machine-intelligence based maintenance of network assets provides a 30% improvement, on average, compared to conventional maintenance.

Another company referenced in this report, Innogy, is using AI to transform customer operations, and more specifically the way it handled mass-market customer inquiries. Since 2017, the company has been using a self-learning content analysis and data extraction system to automatically identify and pre-sort millions of text-based customer inquiries (including emails, letters and faxes) with an outstanding 97% accuracy rate. Fortum and, again, E.ON provided examples of the use of AI to offer new services. The former is using AI to offer district heating users a consumption optimization service that helps them reduce bills by up to 20%, lower their carbon footprint and provide better indoor air quality to end users. The latter is using machine intelligence to offer large industrial customers an integrated energy and process optimization service.

1. Introduction

Lying at the core of the Europe's economic system, European utilities are undergoing some of the most significant and structural changes ever in decades. From an operational perspective, the power system is shifting from centralized generation and predictable demand to complex grid that integrates growing amounts of variable and distributed renewable generation, making it much harder to match predicted demand and planned supply; In business terms, stagnating demand is reducing the value generated by energy production to the benefit of downstream segments in the value chain, thus forcing utilities to search and create new revenue streams and/or look for new business models in the first place.

Faced with these challenges, European utilities are increasingly turning to data-driven technologies to excel in operations, improve customer service satisfaction and create new revenue streams and business models. Indeed, Big Data technologies, smart meter solutions and the increasing deployment of the Internet of Things (IoT), are fueling an operational and technological revolution in European utilities and leading to the rapid introduction of Artificial Intelligence (AI). In turn, AI is starting to emerge as the technology game changer for the industry, helping utilities make operation more cost effective while ensuring optimal utilization of infrastructure and resources to balance supply and demand safety and reliability.

From fraud detection and claim process automation, to maintenance transformation across solar generation plants and medium voltage power lines, and intelligent handling of customer inquiries, this story investigates a number of real-life AI implementations across a series of European utilities with the aim to unveil some of the most significant quali-quantitative benefits and impacts achieved by the industry in Europe over the past few months.

1.1 Main objectives and scope

This story investigates how European utilities are putting to use some of the latest AI solutions across a series of use cases along three main categories, i.e.: operating model transformation, customer experience enhancement, and new revenues and business models.

Through existing IDC research, additional desk research and a series of in-depth interviews, the story aims at:

- Describing how the European utilities are coping with the severe disruptions that are radically changing the industry structure and how data-driven technologies in general, and AI in particular, are proving to be fundamental in winning the challenge;
- Identifying the main use cases and application areas where the European utilities are currently considering and/or already applying AI technologies and where these technologies are already producing tangible benefits for the industry itself and for the wider socio-economic ecosystem as a whole;
- Describing in detail some of the most up-to-date and significant real-life case studies of AI applications in the European utilities and uncovering the underlying benefits for companies and organizations that successfully deploy AI solutions – improved energy recovery rates and network safety, better use and redeployment of resources, increased plant production, better maintenance and grid development planning, etc.
- A set of top-level, preliminary conclusions and policy remarks on the state of the adoption of AI solutions across the Utilities industry in Europe today and how to further support their usage and take-up.

1.2 Methodology and structure

To better understand how European utilities are approaching and implementing AI in a variety of different use cases, we have conducted extensive desk research across a multitude of publicly available sources and IDC existing research material.

We have further carried out in-depth interviews with representatives of Atos[1] – a European multinational information technology (IT) service and consulting company headquartered in France. These secondary and primary research efforts led to the realization of five distinct case-studies in different sectors and across different AI use cases. In particular:

- Enel Green Power (EGP), the renewables divisions of Italy-based energy utility Enel on solar plant maintenance;
- E.ON, one of Germany's largest electric utility companies based North Rhine-Westphalia, on predictive maintenance and energy efficiency as-a-service;
- Innogy, the renewables, network, and retail businesses of German electric utility RWE, on intelligent customer inquiry;
- Fortum, a Finland-based international energy utility company, on intelligent heating management.

The current document is structured along three main sections.

- The first section (chapter 2) describes the recent challenges affecting the European utilities and how AI applications are helping the industry to address the change.
- The second section (chapter 3) is devoted to an overview of the real-life case studies that formed the bulk of the primary and secondary research underpinning this story.
- The final section (chapter 4 and 5) presents the common themes and main lessons learnt from the case studies and provide a few preliminary conclusive remarks.

[1] Four in-depth interviews were conducted with Jorge González Hernando, Head of Solutions, Energy & Utilities, Atos Worldgrid Spain and Victoria Llamazares Lopez, Client Partner & Solution Manager, Atos

2 The Data-driven (R)evolution in the Utilities Industry

2.1 From Policy Ambition to Industry Innovation

The utilities industry sits at the core of the European economic system. Energy utilities were the main driving force behind the EU's progress towards its 2020 targets on climate change and energy[2] and will continue to be amongst the primary contributors to Europe's energy ambitions going forward.

The new EU 2030 climate and energy framework[3] – progressively enabled through the Clean Energy for All Europeans package – is a testament to Europe's role as leader of the global clean energy transition. It builds and expands on more than 20 years of EU-wide reform of the energy industry, which started from the first liberalization directives of the second half of the 1990s and continued through the Third Package for Electricity & Gas markets of 2007. The overarching objective of these reforms is to improve the functioning of national energy markets by strengthening their competitive foundations and laying the groundwork for their integration into an energy union with a common governance, energy security and climate strategy. This two-decade long process has made the European energy system, along with the utilities that operate in it, one the most competitive and innovative in the world.

2.2 Technology and Industry Disruptions

While they remain the beating heart of the EU economy, utilities – particularly energy utilities – face some of the strongest headwinds in their century-old history.

On one hand, energy technology is altering the very fabric of the industry, changing how energy and resources are generated and consumed. It is not only helping decouple energy demand from economic growth, but also fueling a "prosumer revolution", where a growing number of consumers can produce and conserve their own energy. By 2030, IDC Energy Insights[4] estimates that almost 15% of total electricity final consumption in Europe (or more than 460 TWh) will be met by auto-production, over half of which via distributed solar photovoltaics (PV) systems.

This trend is already affecting the way utilities operate and create value.

- Operationally, the power system is shifting from centralized generation and predictable demand to a complex grid that integrates growing amounts of variable and distributed renewable generation. This not only reduces demand for grid-delivered electricity, but also makes it more volatile, making the task of balancing the system (i.e., matching predicted demand and planned supply) increasingly complex.
- From a business perspective, stagnating demand is causing a crunch in value generation which is gradually shifting away from production to downstream segments of the value chain. This is forcing utilities to create new revenue streams to sustain the core business or to look for new business models altogether.

Digital technology, for its part, is changing how people, technology and processes interact. In particular, data-driven consumer technologies have changed not so much the nature of utility services, but how consumers expect them to be delivered. Data and data-driven technologies

[2] The primary objectives of Europe 2020 are a 20% reduction in greenhouse gas emissions compared with 1990 levels, a 20 % share of renewable energy in gross final energy consumption, and a 20 % cut in energy consumption compared to a 2020 business-as-usual projection (https://ec.europa.eu/clima/policies/strategies/2020_en)

[3] The 2030 climate and energy framework includes EU-wide baseline targets and policy objectives for the 2021-2030 period, including at least a 40% cut in greenhouse gas emissions (from 1990 levels), at least 32% share for renewable energy, and at least 32.5% improvement in energy efficiency. (https://ec.europa.eu/clima/policies/strategies/2030_en)

[4] https://www.idc.com/prodserv/insights/#energy-latest_research

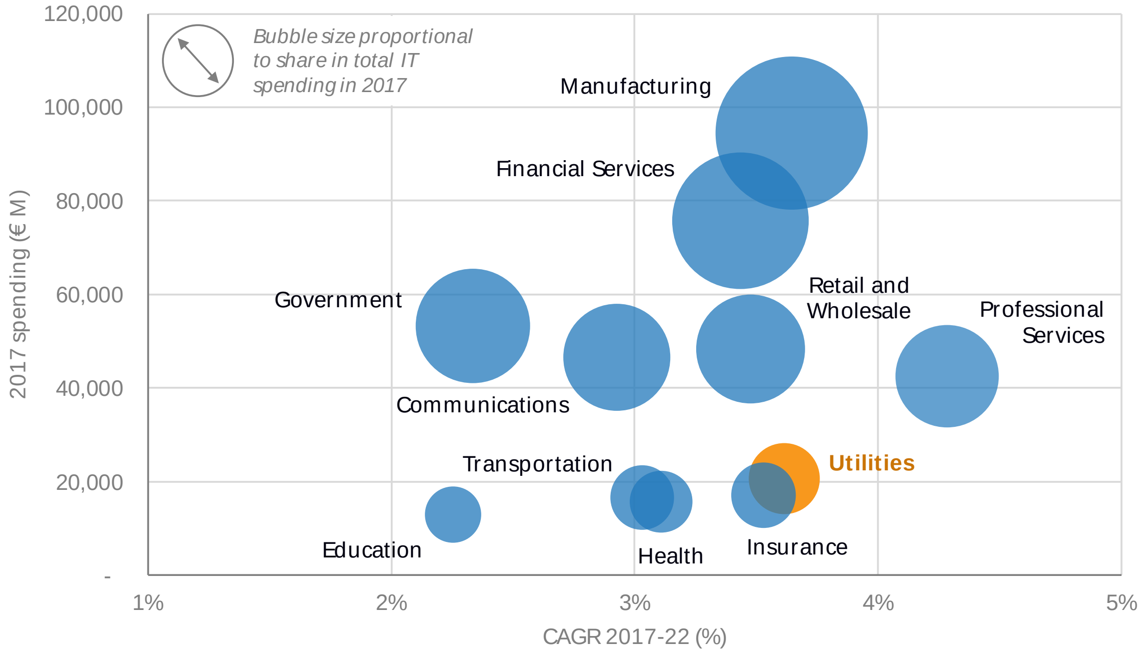
are also enabling unconventional players to enter the energy space. Internet companies, retailers, energy appliance and car manufacturers are just some of the companies looking for a spot in the energy value chain. While utilities have the advantage of being the incumbent supplier and holding the customer relation, in most cases these new brands are more digitally mature and have no legacy infrastructure to defend.

2.3 Addressing Change with Data as a Compass

This mix of policy ambition and industry disruption is driving European utilities to transform faster than their peers globally, using technology to excel in operations, improve customer satisfaction and create new revenue streams and business models - an operational and information technology (*OT & IT*) revolution that is shaping the utilities not only into a data-intensive business but crucially into a data-driven industry.

The scale of this transition is clearly visible in the industry's total spending in IT, telecom services and business services, which is expected to outgrow comparable spending in larger and traditionally more technology-intensive industries. In fact, IDC expects[5] European utilities' spending to expand from about € 20.7 billion to almost €24.7 billion in 2022, a 4% CAGR, among the highest of any industry (Figure 1).

Figure 1 EU-18 ICT Spending by Vertical Market (€M, 2017; % CAGR, 2017-22; % share by vertical, 2017)



Source: IDC, 2019

1.1.1 Putting Intelligence at the Center of Operations

All but 5% of the utilities polled in a 2017 IDC Energy Insights survey[6] said their operating model had changed, and more than half indicated it had changed significantly. The scheduling of asset maintenance work provides a good example. What was mainly a manual process just a

[5] WW Semiannual Spending Guide, 2018 https://www.idc.com/getdoc.jsp?containerId=IDC_P33207

[6] Utilities Reborn Digital: Highlights from the 2017 IDC Pan–European Utilities Executive Summit, IDC #EMEA40828817, May 2017.

few years ago, has become a data-driven process, based on overnight batch processing of planned work and is now becoming cognitive. Machine-learning algorithms and real-time processing are now used to continually optimize workers' schedules, helping companies react to unplanned scenarios, like a road accident or a worker's injury, unplanned inventory shortage, or an equipment failure[7].The extent of this change does not come as a suprise: the energy asset base is expanding and becoming smarter, the utilities' business is becoming more complex by the day and dwindling profitability creates a pressing need for efficient operations, forcing companies to do more with less.

From a technical perspective, European energy utilities are going through an evolutionary transformation that started in the early 2000s and will peak in the early 2020s, where millions of smart electricity and gas meters are being rolled out across Member States. As mass devices, smart meters clearly produce significant amounts of data, but they are only the tip of the iceberg of a generalized move towards connected assets. Utilities are retrofitting their old plants with new IoT sensors while new units are full-fledged digital connected machines. The falling cost of consumer energy equipment means millions of distributed energy resources (DERs), like solar and storage systems, smart thermostats, inverters and heat pumps (not to mention electric vehicles), are appearing behind utility meters, generating vast amounts of structured and unstructured data. To connect all this, hundreds of thousands of sensors are turning traditional networks into flexible smart grids capable of integrating and balancing increasing amounts of variable renewable generation (e.g., from wind and solar photovoltaic systems), including DERs.

Clearly, the complexity of the resulting ecosystem and the amount of data available are becoming too significant to be managed with traditional instruments. After decades of falling computing power prices, Artificial Intelligence (AI) is starting to emerge as a technology game changer for the industry, helping utilities make operations more cost effective, while ensuring optimal utilization of infrastructure and resources to balance supply and demand safely and reliably.

Some of the major AI use cases across utility operations include:

- **Load forecasting** and **grid balancing**, where AI is used to increase the utilities ability to accurately predict system supply and demand in the presence of growing shares of intermittent generation both from utility-scale plants and prosumer systems.
- **System flexibility**, where AI is used to increase the system operator's ability coordinate and optimize the use of flexible loads and generation (e.g., storage, non-essential customer loads, virtual power plants) to meet unpredictable episodes of excess demand and supply.
- **Predictive maintenance**, where AI is used to build and improve data or physics-driven machine models capable of detecting asset failure predictors in large sets of operational technology data (e.g., plant data historians, enterprise asset management systems).
- **Work scheduling**, where AI is used to dynamically optimize workers' schedules based on availability, skills, location, helping field operations react to unplanned and emergency scenarios.
- **Revenue protection**, where AI is used to improve the utilities' accuracy in detecting episodes of so-called non-technical losses (NTL) and energy theft.

1.1.2 Living Up to Growing Customer Expectations with Data and Automation

Customer experience (CX) is a priority for every retailer and utilities are no exception. In fact, for retailers selling undifferentiated products like energy or water, CX is the only differentiator beyond price.

The level of CX is a direct driver of both a retailer's customer satisfaction and cost-to-serve, and in competitive retail energy markets such as the Europe's, these are prime determinants of

[7] IDC FutureScape: Worldwide Utilities 2018 Predictions; IDC # EMEA41791517, October 2017

profitability and customer churn[8]. Moreover, with regulated energy prices[9] set to be phased out across the EU over the next years, European energy consumers will soon grow more aware of price and service differences between suppliers and will more actively switch between them. So, it should not surprise that CX has grown to become the most important business priority for European utilities after growth, and before security and innovation.

However, with customer expectations largely formed outside the utilities industry – in more digitally mature or digital-native industries, like digital media or online retail – boosting the CX is easier said than done for traditional suppliers. To address this, European utilities have set new aspirations for their customer operations with digital at the core, investing in technologies that can best support them to cater to the digital customer as well as trim spending, and AI is emerging as one such technology.

IDC Energy Insights research[10] revealed a strong desire for utility and energy retail customers to move from more traditional communication channels to modern, cheaper ones. Regardless of the channel, there is an abundance of use cases for leveraging AI to offer a CX that is simple, individualized and convenient. For instance, considering traditional phone calls – which continue to force utilities to bear significant costs for call centers – AI can be leveraged to listen to the content and tone of conversations to provide real-time support to customer service representatives and gather insight into the general sentiment of customers toward the company. This enables an energy retailer to preemptively carry out personalized marketing campaigns to improve a customer's trust in the brand. Considering more modern and less expensive communication channels such as mobile messaging applications, specialized chatbots can help utility retailers offer a convenient, customized, and always-on customer interface. Additional IDC Energy Insights research revealed that an overwhelming majority of customer contact was driven by billing inquiries, which do not require particularly complex AI messaging capabilities to be handled.

Additionally, as energy retailers expand into new revenue streams, such as selling or leasing photovoltaic and energy storage systems, it will be fundamental for them to be able to provide CX comparable to those of customer-centricity leaders in the online retail sector. Otherwise, their possibility to sell beyond a commodity will not be grasped.

The attention to machine intelligence in the last, customer-facing stage of the value chain is so strong that in 2019, IDC Energy Insights predicts utilities and energy retailers across the world will double their investments in AI to improve convenience, customization, and control for clients.[11] German utility Innogy, for example, is using computer vision and machine intelligence to automatically analyze, classify and route millions of text-based customer communications every year. This has greatly improved the effectiveness and responsiveness of its customer operation (see Section 1.1.5).

1.1.3 Creating New Value from Data

As mentioned, the traditional utility business model has been coming under pressure, due to technological changes and increased competition from both within the sector – including from the customers themselves – and from new contenders. Utilities right across the world are busy launching new revenue models for their core business, as well as testing new business models away from traditional commodity production and sale. These models have two common traits:

[8] Customer churn refers to when a customer (player, subscriber, user, etc.) ceases his or her relationship with a company. Online businesses typically treat a customer as churned once a particular amount of time has elapsed since the customer's last interaction with the site or service. The full cost of customer churn includes both lost revenue and the marketing costs involved with replacing those customers with new ones. Reducing customer business goal of every online business (https://www.optimove.com/learning-center/customer-churn-prediction-and-prevention)

[9] https://www.euractiv.com/section/electricity/video/regulated-energy-prices-the-end-of-an-era/

[10] Utilities IT Investments in Customer Operations: Results from 2018 Utility Surveys Doc # US43346019 February 2019

[11] IDC FutureScape: Worldwide Utilities 2019 Predictions, IDC #EMEA43108918, October 2018.

- **Servitization** of the energy supply business, pivoting utilities away from traditional commodity production and sale and into the service sphere.
- **Data intensity**, leveraging technology to reshape and grow the business using data – including the utilities' growing energy and customer data assets – as a compass for value.

The EU's position as a forerunner of energy market liberalization and system transformation means some of these new models are appearing earlier in Europe than in most other regions of the world. According to an IDC Energy Insights survey[12], in early 2017, eight out of 10 European utilities had already identified new viable business models and, remarkably, 50% had already launched one.

Several business models are emerging that are aimed at meeting the clients' needs with an end-to-end approach:

- **Energy as a service:** using energy technology and data to take the burden of energy management off the shoulders of their commercial and industrial energy customers;
- **Comfort as a service:** using data to offer comfort, convenience and peace of mind, as opposed to commodity to residential users.

These building blocks of these new business models range from sustainable energy sourcing, to distributed generation, energy efficiency, energy asset management, and reduction of energy price risk for the customer. Advanced data management and analytics technology, including AI, will be increasingly needed if utilities want to differentiate by offering, for example, predictive maintenance as part of their energy asset management proposition; energy optimization as part of energy efficiency; or, again, energy price forecasting to effectively minimize energy price risk.

Flexibility as a service can be thought of as the customer-facing side of system flexibility as an operational capability, or a modern business answer to the looming question of how to manage the increasing share of distributed generation in the energy mix more efficiently. Here, data and AI are used to understand the behavior of customer loads and DERs with a view to offer as a source of flexibility to the grid operator. Turning DERs into a manageable asset on the grid, utility retailers can offer a better investment case to customers (e.g., on their storage systems or EVs) while simultaneously adding flexibility and grid balancing services to their revenue mix. In practice, however, enabling end users to actively participate in what used to be the sole responsibility of the supply side, allowing energy retailers, aggregators and grid operators to develop this business model requires a favorable regulatory framework that not all EU States are currently developing.

A very different approach to offering cheaper energy bills, especially but not exclusively for residential clients is with so-called **energy marketplaces**, where a service provider takes over the role of the customers in searching for the best possible offer on the market. Continuous web scraping, combined with data and AI to understand their clients' consumption patterns, allows energy marketplaces to optimize the tariff choice and automatically switch them to a new supplier when the potential saving reaches a predefined minimum.

[12] Utilities Reborn Digital: Highlights from the 2017 IDC Pan–European Utilities Executive Summit May 2017, IDC #EMEA40828817

3. AI-Driven Utilities already at Play: Application Areas and Case Studies

AI and data-driven technologies show tremendous potential in the utilities industry. For example, Section 3.2 will show how, in just a few months, machine learning has helped one power network operator improve its ability to predict grid failures by a factor of two to three. Similarly, it has helped a gas network operator's ability to detect energy theft by a factor of six. This has had a dramatic impact on these companies' operations.

While it is the most innovative among the industry heavyweights that are currently driving adoption, a process of “democratization” of AI to smaller players in the industry is already underway. Commercial software is embedding ever more complex machine intelligence technology, effectively lowering the barriers to access AI capabilities and expanding the number and variety of use cases. While these use cases are discrete in nature, they are all united by a common goal - breaking down silos across the expanding mass of modern utility data to improve, connect, and automate processes and ultimately help companies shift from reactive, human-driven to cognitive organizations.

3.1 A Look at Popular AI Use Case Families from a Survey Perspective

A 2018 IDC Energy Insights survey[13] confirmed that, while AI is still in its infancy, more than 37% of European utilities are already using or have immediate plans for the technology, adding to another 18% evaluating AI use cases. Early adopters are using AI across a broad spectrum of processes, from customer to asset operations, compliance, IT and sales.

In order of prospective adoption, the most significant AI use case that utilities are working on (Figure 2) are:

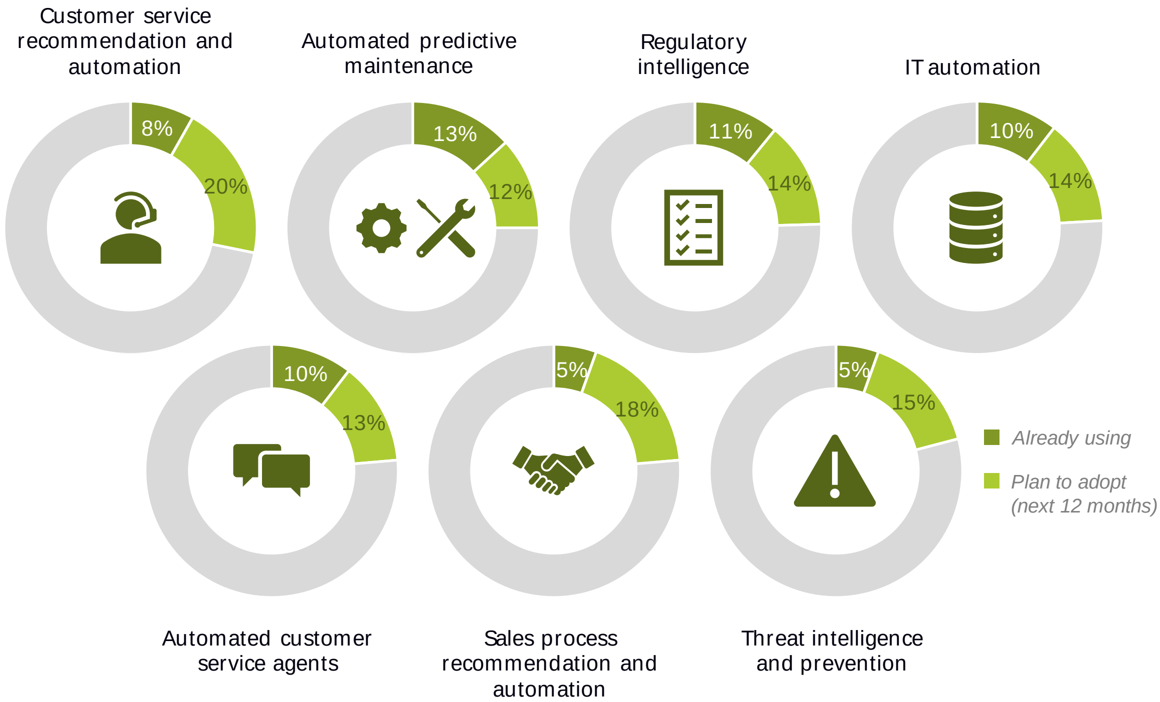
- **Customer service recommendation and automation:** Cognitive/AI computing engines can work with CRM systems to understand customer context in real time and recommend actions to the customer service representatives that are most relevant to the specific interactions and recommend the "next best action" support process to try and offer the best possible service.
- **Automated predictive maintenance:** Machine learning algorithms build an accurate predictive model of potential failures. Higher levels of asset availability results in less factory downtime and lower capital appropriation spending, including lower maintenance costs. The objectives are lower time and cost to repair, longer MTBF and higher FTF rates, and lower factory downtime.
- **Regulatory intelligence:** This use case allows companies to more efficiently address their immediate regulatory compliance — moving beyond the use of traditional structured data to leverage unstructured information and external data. This can be applied in real time to help deliver actionable insights, limit exposure, and reduce the impact of compliance and conduct issues that arise. natural language processing and other AI methods to enable identification, analysis, classification, and management of contracts, while also detecting and managing risks.
- **IT automation:** Cognitive/AI/AI-enabled systems orchestrate the linking of IT systems to become self-acting and self-regulating and automate mundane software maintenance activities. The automation engine can perform decision making and execution tasks of IT systems. New events are learned from IT human operators, not programmed by software programmers. Examples may include automation of fixed price projects from IT service companies.
- **Automated customer service agents:** The aim of the use case is to provide customer service via a learning program that understands customer needs and problems and

[13] How are European Utilities Leveraging Technologies to Accelerate their Digital Transformation in 2019?, IDC #EUR144592919, April 2019.

reduce the time and resources spent in achieving customer issue resolution in the utilities industry.

- **Sales process recommendation and automation:** Cognitive/AI computing engines can work with CRM systems to understand customer context in real time and recommend actions to the sales agents that are most relevant to the specific interactions and recommend the "next best action" sales process to try and qualify or close a sale.
- **Threat intelligence and prevention:** This use case leverages systems that process the intelligence reports, extract the critical pieces of information, structure information in a fixed format, and push the information into the pipeline; connect the dots between different pieces of information; and identify threat to database, systems, website, and so forth.

Figure 2: Most Popular Use Cases for AI among European Utilities (% of respondents)



Q: In which of the following areas does your organization use or plan to use artificial intelligence systems?

N = 220

Source: IDC Energy Insights, 2019

3.2 A Look at Real-world AI Implementations

In this section, a selection of real-world AI implementations in utilities companies around Europe is presented and analyzed. For consistency purpose, we have selected use cases across the three macro-categories used in the first part of this report, i.e., operating model transformation, customer service enhancement, and new revenue and business models.

3.2.1 Operating Model Transformation

Fraud detection and claim process automation for power and gas with Atos

Paris-headquartered global services company Atos has a long history supporting utilities, offering a mix of dedicated technology and industry expertise as well as a portfolio of technology solutions spanning big data and analytics, high performance computing, machine intelligence and automation. Using its proprietary advanced analytics platform Codex, Atos has developed utility-specific use cases ranging from power generation to smart water and energy, including connected home, revenue protection, predictive maintenance, and local smart grid enhancement.

Specifically, over the past five years, Atos has worked on revenue protection with several European electricity and gas DSOs, improving their ability to detect energy theft (which cost an estimated some €1.3 billion a year to the European gas sector alone) as well as streamlining the downstream claim settlement process. Stories from two of these customers are presented below.

The first client, a young mid-sized regional gas distributor, was struggling with its ability to detect non-technical losses (NTL). It had clear indications of unaccounted for consumption, particularly amongst residential and small enterprise customers, but had limited historical records and resources to work with. The company had recently set up a revenue protection unit only to find the team was too small for a process that is highly labor and cost intensive (around €20 per inspection, on average). The team picked candidate points of delivery for inspection in a non-systematic manner, based on the experience of the revenue protection team or by focusing on specific hot spots or neighborhoods.

Using Codex as a framework, Atos developed a service to help the DSO identify potential energy theft episodes based on custom-developed machine learning algorithms for NTL pattern detection. These were made to run over large datasets of both internal and external data, including meter readings, historical inspections, proven NTL profiles, meter device inventory, weather, and socioeconomic data. The service returned a list of candidates, with an attached likelihood score and value, via a set of web and mobile app solutions that helped the customer and field inspectors to follow-up and manage every case. The first analytics pass already showed a dramatic improvement in the hit rate of inspections compared to the pre-analytics method, from 5% to 20%.

However, machine learning makes the analytics process continuous. The results of the first pass were fed back to the model for a second run, ensuring the cycle was optimized to deliver better results over time. With the second wave of inspections, for example, the company further improved its hit rate from 20% to 30%. The significantly larger amount of energy recovered, and much lower overall inspection cost yielded a project return on investment (ROI) under 12 months, while enhancing safety on the network. Data analysis of consumption and non-consumption data also enabled the distributor to detect fraud cases which would go unnoticed with in-house analysis. For example, the operator found out that, contrary to general perception, fraud was not correlated to energy poverty, with detached houses in higher income neighborhoods had among the highest rates of fraud.

Once NTL episodes are verified, distributors must collect all evidence supporting their claims to either bill the customer or try and reach a settlement agreement, either directly or in court. This is a highly labour-intensive manual process, which Atos' second client was trying to address. The customer is a large utility group with activities across the value chain, including in electricity and gas distribution. With over 40,000 NTL cases per year handled by a small team of ten people, the company was seeking to make its claim management processes more efficient in order to effectively bill and settle all claims.

Atos helped the company implement software robots to automate over 80% of all manual back-office claim preparation tasks, including gathering all necessary supporting documents, calculate amounts due and send to end consumers. This reduced the operational cost of the entire NTL management process by 75%.

Smart solar plant maintenance at Enel Green Power

Enel Green Power (EGP), the renewables divisions of Italy-based energy utility Enel, has been actively seeking to build scalable use cases to improve plant production and create efficiency by combining its drone capabilities with new data collection protocols and workflows. This has led the company to start collaborating with software provider Raptor Maps to co-develop and implement new AI technology that will transform how field operations and maintenance are performed at its solar PV sites.

EGP is configuring Raptor Maps' existing AI software solution, Raptor Solar, which was originally developed for post-inspection analysis, and embedding it into existing drone hardware and software in place across EGP's 22 sites and 175MW worth of generating solar assets in North America. The technology will be able to simultaneously capture both infrared (thermal) and high-resolution (colour) imagery of these assets, perform post-processing at the source of the data through edge computing, and deliver real-time analytics to assess the condition of the plant. This information will then be transmitted in real time to EGP's maintenance management system, which will create and deliver a work order with actionable items to be evaluated by the site technician before the drone has even landed. The AI solution is trained to detect major issues in the plant's electrical equipment, PV defects, such as shattered and soiled modules, as well as site-scale issues (e.g., vegetation, flooding, security risks, etc.)

By enabling real-time identification and classification of solar facility faults onboard the drone, EGP aims at cutting the detection-to-repair process from days to hours, thereby boosting plant uptime. Ultimately, Enel plans are to increase the efficiency of its inspections, produce more accurate results and work towards automating inspection process across its solar fleet. Enel and Raptor Maps are also aiming to solve the data post-processing bottleneck that is common in drone inspections at solar plants today. Not only can drone technology and image recognition save hours of driving for technicians and streamline preventive maintenance, increasing the rate of return of an entire renewable portfolio. But performing analytics onboard the drone cuts out the need to transmit large amounts of data over long distances, further slashing the time and labor costs associated with solar infrastructure inspection. By the turn of 2019, EGP North America was planning to train and equip 30 field workers with this technology, thereby laying the foundation for intelligent asset management, preventive maintenance, and AI-based asset inspection. Ultimately, EGP aims at is scaling drone infrastructure and AI applications to support a broad set of use cases across development, engineering and operations. Examples include the assessment of the suitability of new project locations, construction progress monitoring, along with streamlining operational maintenance activities.

In a recent report, Raptor Maps leveraged its data repository of digital PV systems to analyze 2.9 GW across 18 countries. Encompassing some 13 million PV modules across 300 PV systems, the study showed that on average, 1.7% of production is affected by faults that can be efficiently identified through machine-vision and drone technology. Considering the electricity generated in Europe by utility-scale PV systems alone, this is enough to power almost 280,000 European homes for one year.

Predictive maintenance for medium voltage lines at E.ON

E.ON, one of the most prolific users of AI among European utilities, is also using machine intelligence to improve the maintenance process on the medium-voltage grid at its network subsidiary in the northern German state of Schleswig-Holstein.

It has been using an in-house solution co-developed by its distribution system operator (DSO) subsidiary HanseWerk AG and the E.ON DataLab. The solution uses analytical models to detect fault predictors in the form of patterns and inconsistencies across internal and external data, including the age and type of lines, maintenance history and weather data as well as real-time information such as the current load behavior. It then combines this with a self-learning algorithm in order to make these predictions more accurate over time effectively industrializing the prediction of faults and failures before they occur. The solution was initially developed to assess when medium voltage cables in offshore windfarms were due for replaced based on a mix of internal data (e.g., geospatial, asset and grid operations data) and external data on weather, lightning strikes and water salinity.

The results have been extraordinary. After nine months of use and training of the algorithm between 2017 and 2018 the likelihood that E.ON could predict a defect in the power grid had increased by a factor of two to three. By extension, defects in the grid can be used as predictors of more widespread power failures. Therefore, the increased accuracy of predictions has not only benefited E.ON through more effective maintenance, but translated in a further improvement of E.ON's already strong distribution reliability and security of supply indicators in Schleswig-Holstein. In fact, the output from the project has prompted the company to bring forward a dozen maintenance projects in the region, effectively avoiding defects to cause widespread failures.

E.ON has been working to extend the solution to substations and intended to expand the analytical model to also cover other assets, such as low voltage cables. The company's research shows that the intelligent maintenance process provides on average a 30% improvement compared to the conventional one, while potentially bringing other benefits in the form of improved planning for grid construction projects and, on a wider scale, better investment planning and budget allocation.

3.2.2 Customer Service Transformation

Intelligent customer inquiry sorting at Innogy

At Innogy – the renewables, network and retail businesses of German electric utility RWE – the domestic private and commercial customer division alone receives approximately 20,000 text-based customer inquiries per week, or more than 1 million per year, including emails, letters or faxes. To fulfill these customer communications, which have grown manifold in recent years, the company uses external service providers located throughout Germany. Until recently, however, there was no consistent inhouse solution for the management of written inquiries across locations and channels. Additionally, there had been no satisfactory way to efficiently manage service quality and distribution of inquiry volumes and resources with external service providers.

Since 2017, the company has been using a self-learning content analysis system developed by Cologne-based business processes and customer service automation software provider ITyX, to automatically presort these communications. The solution digitally records and analyzes emails and text messages and scans and analyzes paper letters via optical character recognition (OCR). It then interprets their content and classifies communications using cognitive keyword-based analytics (linked networks with over 100,000 nodes develop during the AI learning process) and extracts relevant business and personal data based on inquiry type. With about 97% of cases identified and classified correctly, the precision of the entire process is outstanding.

Communications are then transferred into the CRM system that is used by all front- and back-office sales and customer support staff. Work tasks are automatically created and routed based on staff function and qualifications. For example, the task of updating a customer's bank account details will be automatically assigned to a junior service representative, while a specialist with many years of experience will be assigned a complex task, even though no-one apart from the AI software has read anything up to that point.

The system's process management service proactively updates prospects and customers on the status of their inquiry. Inquiring prospects will even receive a quote that they can confirm directly via a text message that is handled by the system to begin the contract process. Sales and customer service management receive daily reports on processing quantity and quality.

Innogy has since extended the system to its Westnetz network subsidiary to process their post. While Westnetz only receives about 500,000 customer letters per year, the content of the inquiry tends to be more complex than the one handled by the retail unit.

3.2.3 New Revenue and Business Models

Intelligent heating management at Fortum

Finland-based international energy utility Fortum is using AI to optimize heat production and supply, save resources and reduce CO_2 emissions by predicting weather patterns, human behavior and energy flows. In 2017, the company announced the launch of Lämpöpilotti ("Heat Pilot"), a service that helps housing companies and building owners that use water-based district heating systems better manage heat consumption leveraging sensors and AI. The service is now available both as part of Fortum's connected home solution and district heating offering.

The service is based on a solution by local IoT specialist Leanheat which is capable of cutting the peak heating load of a building by about 20% by shifting space heating needs in periods when domestic hot water is also heated. This means providing extra heat to the building before domestic hot water consumption is predicted to increase (e.g., when people are taking showers in the morning and evening), during which times the amount of space heating can be reduced without affecting indoor temperatures, and in fact avoiding overheating.

During a two-week post-installation "learning" period Leanheat's machine learning software creates a unique dynamic model of each building thermodynamics. Based on this model, the service then adjusts heating in residences based on real detected indoor temperatures, weather forecast, and predicted building usage patterns as well as by striking a better heat balance between adjacent residential units. By using the service, households can save about 10% in direct heating cost and another 20% in basic charges without compromising on comfort, in fact improving indoor air quality through a smoother temperature and humidity profile. The system also helps improve the carbon footprint of district heating. The peak power demand of buildings during the coldest days of the year being one of the key drivers for fossil fuel-based in heat generation and during the 2017-2018 heating season Leanheat estimates it was able to save over 30 MW of peak power with 35,000 apartments.

The cooperation between Fortum and Leanheat started in late 2015 as a pilot project across 40 residential buildings and 2,000 apartments. With the launch of Lämpöpilotti in 2017, the service has been extended to all housing companies and building owners in Finland using district heating. A testament to Fortum's strategic shift from just offering energy, to offering a service of comfort for residents, heating rationalization and savings for housing companies, as well as optimization of district heat production for itself, in a way that saves environmental and economic resources. By early 2019, for example, installations will cover more than 100,000 apartments.

Based on the same algorithms, Fortum has implemented dynamic heat pricing as well as the ability to buy back heat from its customers in the first of a kind Open District Heating network. In the longer term, the company believes AI can help it shape heating networks into energy storage systems capable of balancing the variability of wind power production.

Energy efficiency as a service at E.ON

In 2018, Germany's E.ON partnered with manufacturing analytics solutions provider Sight Machine to integrate its technology in E.ON's portfolio of B2B energy efficiency solutions. The two companies decided to blend their respective expertise to develop digital solutions for European manufacturers designed to optimize energy and core manufacturing processes in unison. Alongside the partnership, E.ON's Innovation Scouting and Strategic Co-Investments (SCI) unit has made a venture capital investment into Sight Machine.

E.ON will use Sight Machine's AI technology to expand its Optimum B2B energy intelligence and analytics software product and enable large energy consumers to turn both manufacturing and energy data into actionable information. The combined solution will enable E.ON to offer large energy consumers an integrated solution that pulls and analyzes data from across manufacturing sites to improve machine uptime and utilization through predictive maintenance, as well as identify production bottlenecks, quality issues, and energy optimization gaps.

E.ON claims its new data-driven approach to energy efficiency has already produced significant improvements for its customers, who have been able to cut their energy costs by up to 40% and reduce their carbon footprint by an average of 30% across more than 5,000 sites. E.ON has been using its Optimum energy management system as a platform for:

- Energy awareness, by making the customer's energy use visible and offering consumption reporting and analytics.
- Behavioral change, through individual energy efficiency guidelines and involvement of the customer's staff.
- Energy usage optimization, for example through control of heating and air conditioning technology, modernization of building and control technology and of lighting systems.
- Managed efficiency services via remote connection to E.ON's Energy Management Centre.

The goal of the new integrated solution will be enabling customers to achieve even more efficient operations and lower CO2 emissions starting from this baseline.

4. Conclusions and preliminary Policy Remarks

The case studies and real-life examples highlighted in this research have confirmed that AI is playing an increasingly pivotal role in the future of the European utilities and is rapidly becoming a true game changer for an industry that is more and more data-intensive and with business and operating models that are being disrupted by the day.

The case studies have shown that AI deployments across European utilities have not only helped to successfully address a variety of business and operational challenges but, more importantly, have also produced quantifiable specific benefits for the utilities themselves often leading to more general positive impacts not directly attributable to AI.

Table 1: Overview of the Six Case Studies

Company	Business Challenge	Area of AI Deployment	Specific Benefits of AI	Wider impact
Atos	Cost and efficiency of energy theft detection and claim processing	• Non-technical loss (NTL) pattern detection and case management • Robotics claim process automation	• Improvement of hit rate of NTL inspections from 5% to 30% over the first two algorithm runs. Project-specific ROI of under 12 months • 75% reduction in the NTL claim management process	• Improved energy recovery rates and network safety • Redeployment of resources to other areas of revenue protection (e.g., engagement with local authorities, subcontractor education, etc.)
Enel Green Power	Cost of PV (Photovoltaic) plant inspection and process efficiency from fault detection to maintenance execution	Real-time PV fault recognition onboard in-flight drones and automated work order creation	• More efficient plant inspections and more accurate fault detection • Reduction of the detection-to-repair process from days to hours	• Plant production improvement by extension • Possibility to automate the inspection process across plant fleet
E.ON	Effectiveness of fault detection and efficiency of maintenance on the medium-voltage grid	Fault prediction through data inconsistency and pattern recognition	• Overall 30% improvement over conventional maintenance • 100% to 200% increase in accuracy of defect prediction after nine months of training the algorithm	• Improvement of distribution reliability and security of supply • Better maintenance and grid development planning • Horizontal and vertical extension of the solution to cover other assets
Innogy	• Consistent handling of mass-market customer inquiries • Efficient management of external service providers and service quality	Automatic identification and presorting of customer inquiries through self-learning content analysis and data extraction	• 97% of customer inquiry cases identified and classified correctly on an ongoing basis • Automatic case routing to appropriate staff through CRM	• Automatic proactive customer updates (including tariff quotes) through process management service • Automated

			system	performance (volumes and quality) reporting
Fortum	• Heat consumption optimization for utility customers • Efficient and sustainable production and supply of district heat for utilities	Heat consumption pattern prediction using weather, behavioral and energy flow data	• Reduction in district heating costs by 10% to 20% and lower carbon footprint for customers • Decrease or shift in peak hot water demand and related load • Better indoor air quality through smoother temperature and humidity profiles	• Dynamic heat pricing • Ability to buy back heat from customers • Possibility of using heating as energy storage systems to balance variable wind power production
E.ON	Machine uptime improvement, production, quality and energy optimization for large industrial energy customers	Rootcause, optimization, and predictive analytics based on an integrated energy and process digital twin	• Up to 40% lower energy costs 30% lower carbon footprint on average across more than 5,000 customer sites using energy analytics only	• Better energy usage visibility and awareness • Behavioral change through custom energy efficiency guidelines • Energy usage optimization and efficiency investment

When looking at the case studies in some more details, we could argue that:

- The case studies outlined in this research do not represent the mainstream reality for now but their significance – in both "traditional" data-driven use cases (such as those of predictive maintenance, fieldwork optimization and fraud detection) as well as in more innovative realities (such as automated customer service, flexibility, and grid balancing) – is expected to grow remarkedly over the next few years.
- The importance of the AI implementation and of the subsequent "cognitive revolution" in the Utilities industry is also destined to increase as a direct consequence of Europe's legacy of early energy market liberalization and leadership in energy system transformation and climate initiatives. In other words, European utilities (especially those operating in the energy market) are on average more advanced than their peers elsewhere and this constitutes a fertile ground for further and more beneficial implementations of AI and data-driven technologies in the sector, thus reinforcing Europe's leading position vis-à-vis other regions of the world.
- Yet, there is room for policy initiatives at both European and national level as uneven energy market guidelines and regulatory incentives are still at play across the Member States. Some use cases, for example, have been pursued successfully and systematically in some European countries but not in others. To achieve the benefits of a truly European level-playing field and of a truthfully harmonised energy market, more policy guidance would be beneficial.
- What is more, the real-life use cases featured in this research show that the big names in the business and large utilities are among the frontrunners of AI implementations, often co-developing with small companies and startups, and sometimes incubating and providing venture capital at the same time. In addition, the increasingly accurate information produced by AI, and their associated potential on the renewable energy production, are likely to spark higher investments from businesses and augment the willingness of individuals to invest in renewables. For this to concretely accelerate the energy transition towards renewable energy sources and the factual contribution to the EU's long-term strategy for a climate neutral economy, more help (also in the form of

funding or financial help otherwise) is likely to be needed, especially for SMEs and individuals.