IT CHANGES EVERYTHING
Issue no. 2 – October 2019

DOES DIGITAL TECHNOLOGY POWER PROGRESS?

EDF

Industry 4.0, trust and big data, and artificial intelligence

Digital technology is revolutionising how we produce, consume, interact, travel and lead our lives. For 25 years, there has been a constant flow of technological advances.

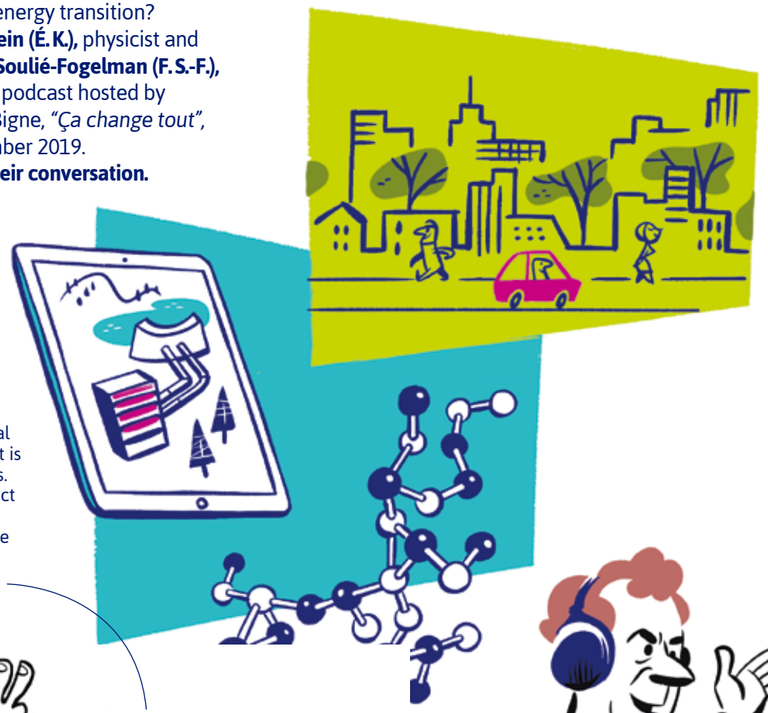
They open new horizons, but also compel us all – individuals, companies and States – to reassess the balance, define new rules and adapt. Innovations are a source of progress, but they raise as many questions as they answer. They touch on core issues, often of an ethical nature, related to the evolution of work, individual freedoms and data protection. That is why we decided to make digital technology the theme of this second issue. We asked ourselves a key question: **Does digital technology power economic, social, individual and environmental progress?**

To answer, we must understand the purpose of this technology and the motivation behind it, think outside the box and look at different points of view. At EDF, we believe that digital technology is essential to the energy transition; it facilitates it, accelerates it and makes it available to everyone.

IT CHANGES EVERYTHING

Does digital technology power progress?

Can digital technology and artificial intelligence (AI) facilitate the energy transition? This question was put to **Étienne Klein (É.K.),** physicist and scientific philosopher, and **Françoise Soulié-Fogelman (F.S.-F.),** AI expert, on the episode of the podcast hosted by Thierry Guerrier and Yolaine de La Bigne, *"Ça change tout"*, released on 11 September 2019.
Here's a quick look back at their conversation.

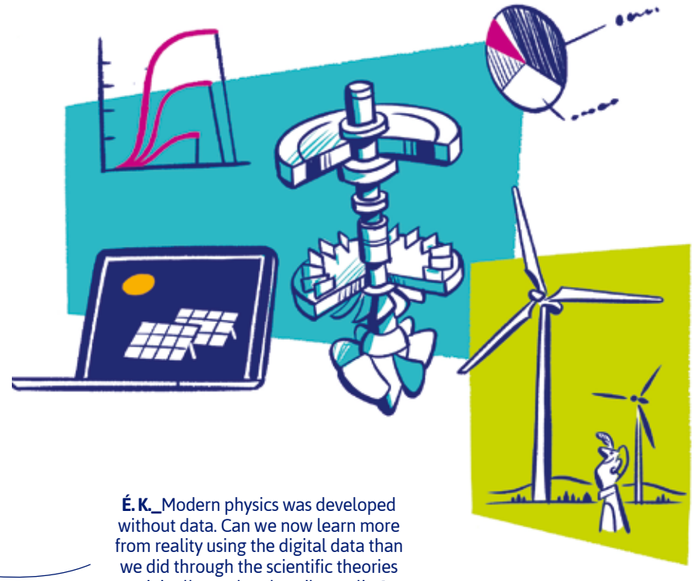


F.S.-F._ When you work with digital technology, you generate data that is collected and fed into algorithms. Nowadays, if you are able to collect massive amounts of data and interconnect them, you can create something very powerful.

É.K._ The word "intelligence" is rather ambiguous. In English, intelligence means the collection and management of information, which is why we call it artificial intelligence. Whereas in other languages, like French for example, intelligence refers to the ability to create new concepts, which AI is incapable of doing.

F.S.-F._ The problem with AI is that if we use huge amounts of data, the algorithm will require a lot of energy to analyse it all. In order to move towards a "greener AI", we need to be more efficient, consume less energy and shift from big data to small data.

É.K._ Our energy comes from many different sources and all this data allows us to use AI to optimise distribution. However, if all our decisions are taken by algorithms that don't explain how they arrived at their conclusions, would we still be able to understand what is going on with the environment and really analyse the situation?



F.S.-F._ By rolling out AI in the world of work, we can create augmented employees. But when crucial decisions are made by people using AI tools, you could debate whether or not they are actually applying any expertise.

É.K._ Modern physics was developed without data. Can we now learn more from reality using the digital data than we did through the scientific theories originally used to describe reality?

F.S.-F._ What a great question, that's the fundamental discussion in science! In the past, science came up with theories and then sought to prove or refute them with data. Has this approach been turned on its head in today's world? Can data come up with the laws of physics?

É.K._ The major challenge posed by the energy transition isn't just technical or scientific, it's also cultural. The way we talk about things frames the way in which they are used.

F.S.-F._ For AI to be rolled out effectively throughout Europe, we need to be able to develop a kind of AI we can trust. It needs to be accepted and understood by everyone.

The podcast *"Ça change tout"* is available on all platforms and can be downloaded on Apple podcasts, Spotify, Deezer, Podcast Addict, Google Podcasts and many more, including edf.fr.

ÇA CHANGE TOUT

Interview

“Companies’ ability to act is decisive in energy and the fight against climate change.”

Étienne Klein

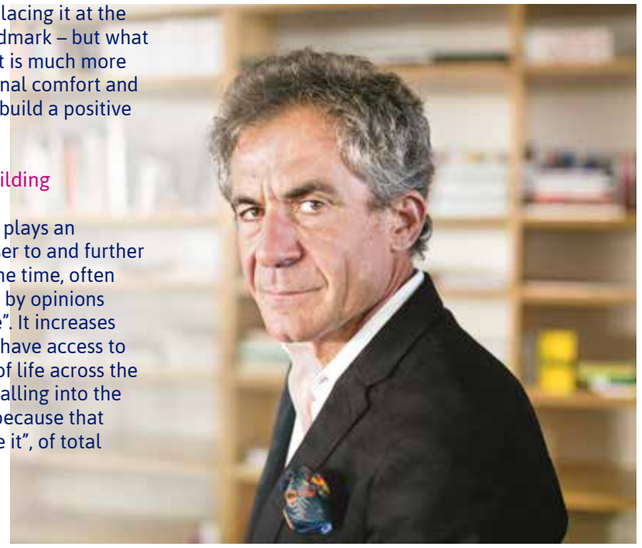
Physicist, head of the LARSIM physics and chemistry research centre at the French Alternative Energies and Atomic Energy Commission (CEA) and scientific philosopher.

Étienne Klein looks at the philosophy of science and technology. His work has often made him question the position of progress in our societies, and how it influences our ability to define the future. He believes that "innovation is now replacing progress". The repercussions of this shift will be felt more deeply than it may first seem, as Klein explained during our interview.

— The word "progress" has suffered a strange fate. Ever since the Enlightenment, it has gone hand in hand with the idea of modernity, but it now feels like no-one wants to talk about it anymore. Why do you think that is?
Étienne Klein: It's not just a feeling, it's a fact. I analysed speeches for a book (*Sauvons le progrès,* published by Éditions de l'Aube in 2017) and found that the word "progress" has quite simply disappeared from public discourse. Or rather, it's being replaced – by "innovation". There's nothing coincidental about this semantic shift; the rhetoric that goes with the idea of innovation is based on the idea that time corrupts. If the mere passage of time corrupts and causes damage, we must innovate just to preserve and repair what we already have. We therefore criticise the present – with that famous refrain, "nothing works anymore" – to justify our need for innovation. Basically, to quote Tancredi from the novel and the film "The Leopard": "if we want things to stay as they are, things will have to change." The word "progress" is part of an entirely different reasoning, where time builds. It is an ally, driving humankind and helping us advance.

— Why, then, has progress disappeared from our conversations and general outlook for the future? Because the definition that you just gave is more positive and stimulating than that of innovation.
É. K.: Perhaps we are living in a kind of transition period, a sort of backlash from the year 2000. People from various generations fixated on this date for a long time, pinning their hopes on it. But once we reached that landmark year, we went into a sort of descent – like a mountain-climber who is very motivated about reaching the summit, then much less so about returning to the base of the mountain. Whether the year 2000 fulfilled its promises or not is irrelevant; it was about our shared future, for everyone. It represented the future, placing it at the heart of our present. Perhaps we need to set a new landmark – but what should it be? And, let's be honest, progress as a concept is much more demanding than innovation. It's about sacrificing personal comfort and the status quo in the hope of making improvements to build a positive and realistic future for everyone.

— So, the idea of the common good is essential to building the future?
É. K.: Yes, I think so. In a broad sense, digital technology plays an important, but contradictory, role. It brings us both closer to and further from other people. It opens our horizons yet, at the same time, often encloses us within a certain vision of the world, shaped by opinions that resemble our own – what we call the "filter bubble". It increases inequalities, reinforcing the divide between those who have access to technology and those who don't, but improves quality of life across the globe. Looking at these contradictions, we must avoid falling into the initial trap of picking a side for or against technology, because that doesn't make sense. This idea of "I like it" or "I don't like it", of total outrage or unwavering support, is a huge problem today and contributes to our difficulty defining our shared future. We should observe and analyse technology, without evangelising or despairing. People will always dream of living in a different age but, for the time being, it's not really possible. And even people who fantasise about living in the 1920s, to experience the culture for example, probably wouldn't want to go to a 1920s-era dentist. So, you see, we're stuck in the present. The only way out is the future, but right now it scares us.



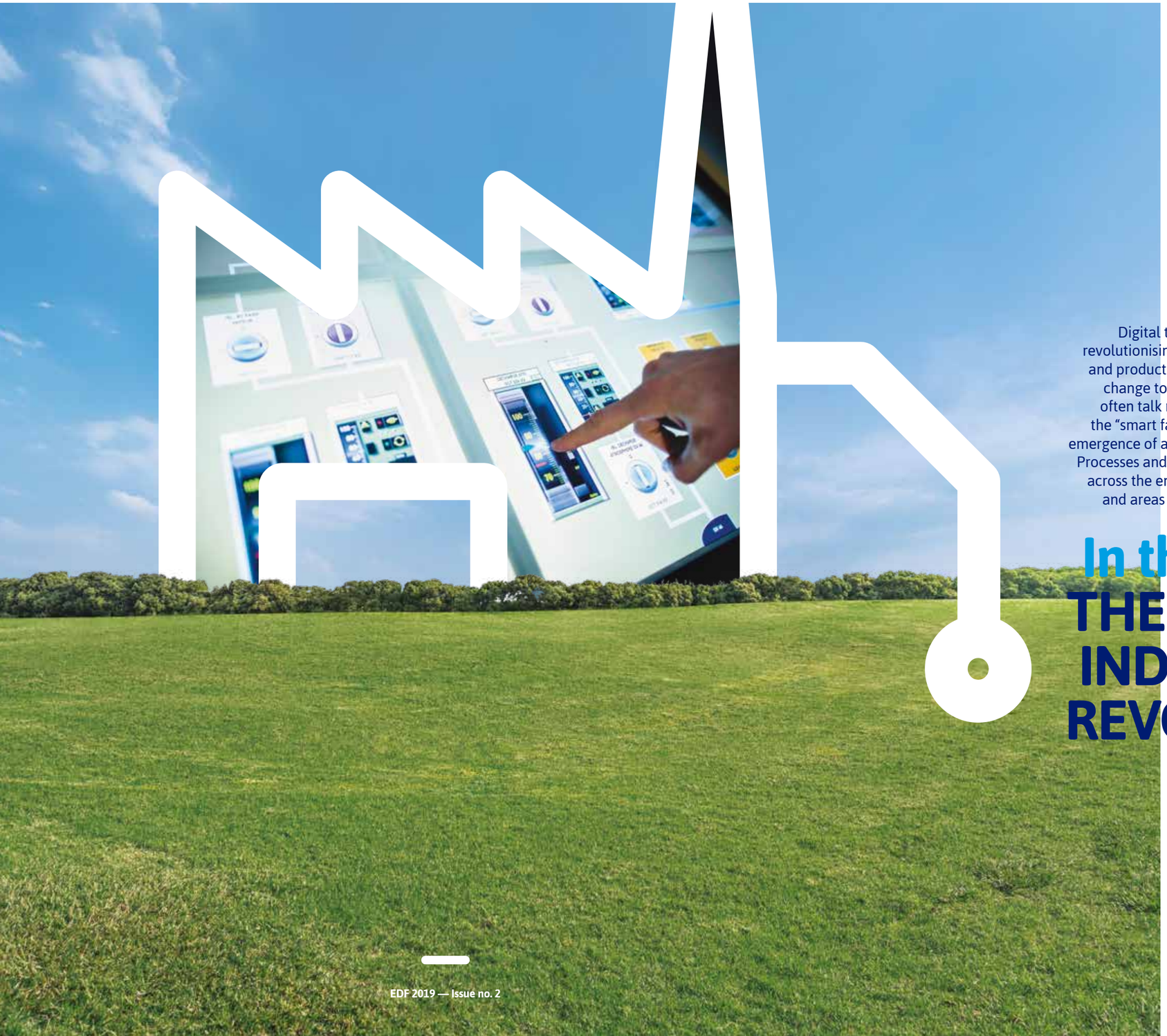
— Are industry and companies currently places where we can really create the future?
É. K.: Yes, if they continue laying the path to the future by planning ahead and setting a purpose. Planning ahead is about looking at the present and suggesting a route to take. Setting a purpose is a bit different; it's about imagining the future, designing it, then charting the course needed to get there. Companies can take this approach, shaping the future in line with what we want it to be – especially given that the ability to act is decisive in many areas, such as energy or the fight against climate change. That is why we must think about the future in order to implement the right solutions. This is where I feel like engineers and manufacturers need to be more involved in debates about technology. They can present pragmatic and reasoned arguments about this better than anyone.

— Digital technology provides an extremely efficient, incredibly easy-to-use service. Does this user-friendliness make the idea of progress less impressive?
É. K.: There is an amazing amount of technology and scientific progress crammed into our smartphones. They are incredibly complex objects. And yet, you don't need to read the instructions in order to use them. These devices' features almost seem normal. We don't really value technological progress anymore. And then, as an inevitable consequence of the efficiency and ease of use of these devices, people outsource, entrusting a number of their own skilled activities to technology. Which takes us to the crucial topic of responsibility: we should uphold our responsibilities, in the face of the digital revolution and artificial intelligence, by setting specific objectives to achieve what we want, according to what we know. Particularly what we know – I cannot stress that enough, in a time when "fake news" competes with reality on a daily basis. Our convictions should not develop more rapidly than our knowledge.

— What do you think we should do to "revitalise" progress and reintegrate it into our vocabulary?
É. K.: The concept of progress is a fundamental part of modernity itself, and we should take it seriously, looking at it critically. I suggest that we carry out a thought experiment, as we do in physics. Imagine if some of the major figures of the Enlightenment, like Condorcet, Diderot and d'Alembert, came back to life now, and we gave them an overview of current society. They could attend high-school level maths classes and learn about recent major scientific developments, such as the discovery of the Higgs boson particle. And we could explain television to them, how we transmit images and sound. They would be impressed – stunned, even. They would ask, "what do you use it for?" When you turn the TV on, they would probably be stunned again – but for different reasons. On the drive back to their hotel, they would see people sleeping in the streets. Again, they would ask, "what have you used these amazing developments for?" Which takes us back to the idea of responsibility. Where do we want to go? What are our shared goals? And what can we use to achieve them? By answering these questions, we can establish our collective future and reignite progress.

"Our convictions should not develop more rapidly than our knowledge."

Étienne Klein



Digital technology is everywhere, revolutionising our methods of consumption and production and producing an in-depth change to the face of industry. People often talk now about “industry 4.0” and the “smart factory”, terms that refer to the emergence of an entire new industrial paradigm. Processes and procedures are being reworked across the entire value chain, and new jobs and areas of expertise are developing.

In the age of THE FOURTH INDUSTRIAL REVOLUTION

What do a pair of trainers, a car and an airliner have in common? On the surface, nothing. But the digital transformation of manufacturing has had an impact on all sectors and types of production, property and consumption, from the simplest products to the most complex. This groundswell is related not only to issues of a purely technical nature, but also the shift of customer expectations to greater reactivity, price competitiveness and customisation. In other words, consumers now expect items of high added value to be manufactured in limited edition and as quickly as possible, at mass-production prices. To rise to the challenge, manufacturers are digitalising processes to improve quality and engineering performance across the entire value chain, while optimising costs and applying the most stringent standards in compliance and health and safety. The nuclear reactors of the future may well be mass-produced, like planes. The idea may sound like science fiction, but it is actually a genuine avenue for development – being the business model behind the Small Modular Reactor that EDF is working on with TechnicAtome, Naval Group and the Atomic Energy Commission (CEA).

New technology, new challenges

New technology is proliferating rapidly at the heart of industry 4.0, accelerating the creation of new processes and services. Examples include collaborative robots or “cobots”, virtual and augmented reality, the Internet of Things (IoT), deep learning, artificial intelligence, cloud computing, digital twins and 3D simulations, big data and additive manufacturing. When implemented in factories, these technologies can help improve quality, minimise costs and save time, boosting the flexibility and performance of manufacturing equipment and the supply

chain. Processes are being rebuilt, tools transformed and professional behaviour adapted.

In short, the digital transformation is creating a new business model that is not only smarter and stronger, but also more agile, capable even of reinventing how we think and behave. In order for the benefits of this digitisation to be fully felt, manufacturers should rise to challenges related to three different areas: technology, organisation and people.

Expertise and learning in the digital era

Digitising manufacturing equipment entails adapting certain jobs and creating new ones. IoT is used to easily obtain information gathered by sensors or locate people and equipment. Robots are used to reorganise tasks, relieving operators of their most strenuous, repetitive and high-risk activities, so that they can be more involved with value creation. Artificial intelligence and 3D simulations are opening up the range of possibilities. Additive manufacturing is facilitating the industrialisation of extremely complex and tailor-made parts. Lastly, data sharing is making it possible to manage more effectively; companies are shifting from an organisation based on paper documents and a structure where business divisions work separately to a data-focused extended enterprise.

The digital transformation is therefore making an impact on professions, working setups, production and collaboration methods, and how people work with machines at every level of the company. But the change also goes beyond the company, affecting the entire value chain and involving all project partners. This integration is key to improving the performance of the organisation as a whole, as well as the role and tasks of each individual within it. By changing how we interact and collaborate, it also enables us to invent new business models – and new ways of working – that are more sustainable.

A beginner's guide to digital technology

Artificial intelligence (AI): the theories and techniques used to create machines that can mimic human cognitive function.

Big data: a huge amount of data in various forms: text, photos, videos, etc.

Blockchain: record-keeping and sharing technology. It is an open, decentralised and secure database that can be verified by all parties involved.

Cloud computing: technology that uses a network to harness the computing power and storage capacity of remote servers.

Cobotics: collaboration between people and robots.

Cybersecurity: all of the technology, processes and practices that aim to protect networks, computers and data against attacks, damage and non-authorised access.

Data analytics: a data analysis process used in a number of fields to improve decision-making. A large amount of raw data is grouped together in order to make conclusions and observe trends that would not be visible through usual methods of analysis.

Data lake: a repository of a large amount of raw data in its natural format stored for future use.

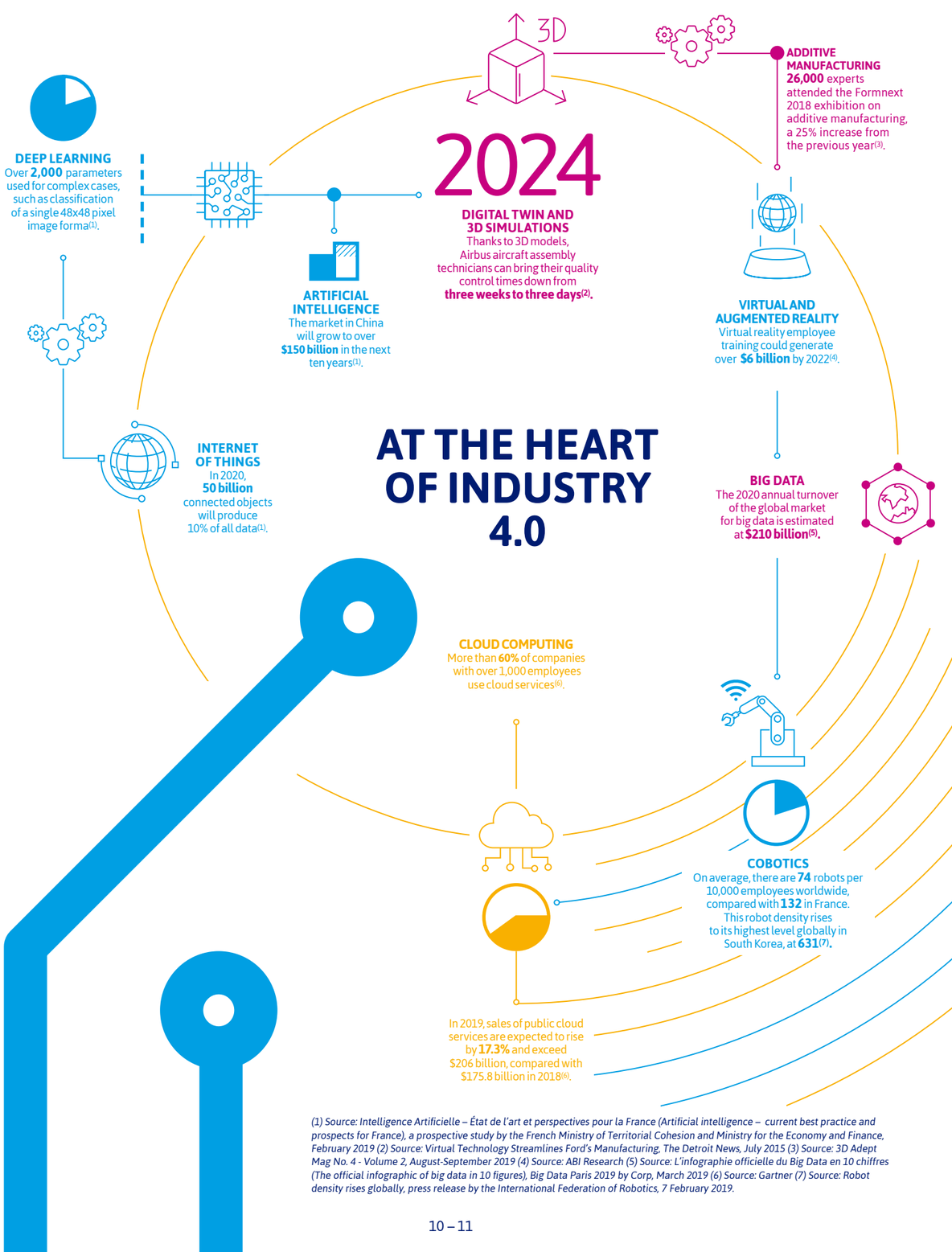
Deep learning: artificial intelligence that mimics the human brain to process and understand raw data.

Digital twin: a digital replica of an object, process, or system that is used for various purposes.

Extended enterprise: a type of evolving organisation to develop shared strategies, tools, methods and frames of reference with partner companies.

Internet of Things (IoT): interconnectivity between the internet and objects, places and physical environments.

Plant Lifecycle Management (PLM): all of the concepts, methods and software that can be used to create and maintain industrial facilities throughout their lifetimes.



(1) Source: Intelligence Artificielle – État de l'art et perspectives pour la France (Artificial intelligence – current best practice and prospects for France), a prospective study by the French Ministry of Territorial Cohesion and Ministry for the Economy and Finance, February 2019 (2) Source: Virtual Technology Streamlines Ford's Manufacturing, The Detroit News, July 2015 (3) Source: 3D Adept Mag No. 4 - Volume 2, August-September 2019 (4) Source: ABI Research (5) Source: L'infographie officielle du Big Data en 10 chiffres (The official infographic of big data in 10 figures), Big Data Paris 2019 by Corp, March 2019 (6) Source: Gartner (7) Source: Robot density rises globally, press release by the International Federation of Robotics, 7 February 2019.

Industry 4.0:

SMARTER AND MORE DIGITAL

The fourth industrial revolution, driven by the digital transformation, is changing society. This transformation is making electricity activities smarter and more agile at all levels – generation, transport and distribution – and plays a central role in accelerating the energy transition.

Industry 4.0 and digitisation create inexorable progress in a number of ways. We can, for example, integrate renewable energy on a wide scale without necessarily having to build new infrastructure, use digital twins to digitise nuclear engineering work in order to harmonise and optimise processes and methods throughout plants' lifetimes, and harness big data to boost the effectiveness of predictive maintenance. Within the EDF group, all energy sources – nuclear, hydropower, wind and biomass – stand to gain. And synergies are developing, like in the *Usine Data Analytics pour la Production* (the Data Analytics for Generation Factory) programme, set up in 2018.

The age of collaborative engineering. Like other industries that provide cutting-edge engineering, such as satellite, submarine and plane manufacturers, the nuclear industry now faces numerous technical, regulatory and financial requirements. The volume and complexity of these requirements increases constantly, and project management continues to evolve with them. Digital technology is truly driving transformation, rebuilding and simplifying processes and methods in order to better manage the complexity of major industrial projects throughout their lifetimes – at the design, build, operation and decommissioning phases – particularly by applying systems engineering standards. These standards are turning plants into single products made up of different systems, such as I&C systems, turbine islands, coolants, reactors and electrical output. Specialists meet at a physical site at the beginning to figure out how to work together, then collaborate remotely using a virtual model – the digital twin.

Optimising the existing nuclear fleet. There are 58 reactors in France's nuclear fleet. The digital transformation taking place within it stems from industrial mobility, data analytics and 3D data, with the aim of simplifying operations for users on the ground and improving performance. All existing nuclear facilities are currently being digitised in order to create their 3D digital twins. Information such as technical documentation, electrical and mechanical diagrams and building plans will then be added to all equipment models. These additions make the model a digital hybrid that acts as a 3D data gateway, allowing users to visualise the facility's future at every stage.

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All stakeholders will be able to easily access the data for each plant in real time. The PLM model will enrich its own content by archiving even the most minor operations carried out from the site's design to decommissioning, which could cover a period of a century. Professionals or supervisory authorities can retrace the life story of any aspect of the site in just a few clicks.

The digital transformation also enables us to break down barriers and create continuity between different partners within the extended enterprise. Ultimately, the performance of the entire French nuclear sector will improve and 2,600 companies will benefit from advancements in digital technology. With this in mind, a dozen independent bodies and companies – including EDF and Framatome – signed an agreement at the end of 2018 to create a digital platform for nuclear pressure equipment. The platform will enable the sharing of schedules, documents and engineering data and make it easier to obtain equipment certification within industrial timeframes by making it easier for different parties to communicate.

More data to better anticipate operations.

Facility performance is improving, thanks to the spread of predictive maintenance enabled by big data. Collected within the *Usine Data Analytics pour la Production* programme, data from all energy providers – nuclear, hydropower, wind, solar and thermal – is categorised and analysed to anticipate maintenance operations and increase facility availability, with shorter maintenance times and fewer unplanned incidents.

Field operators can access their IT systems while on the go, so that they can work more easily and effectively. EDF is also rolling out tools and materials to help maintenance staff at wind and solar farms and nuclear sites be more mobile. For example, at the end of 2018, 4,400 tablets were available at nuclear sites to optimise equipment maintenance and site supervision. At the end of 2020, there will be over 10,000. In addition, EDF Renewables has launched the Digital Vision Initiative to develop a digital culture for all business lines.

Boosting competitiveness and performance.

— Nuclear: increasing lifespans. Through in-depth analysis of maintenance, chemical and operational data, the lifespan of steam generators can be optimised by reducing the number of descaling operations that need to be carried out. That is how we were able to anticipate the development of clogging in the generators according to operating conditions, and take actions to limit it.

— Hydropower: monitoring to improve productivity. Super Viz'Orte is a big data tool used to monitor hydroelectric facilities in order to assess machine deterioration and improve maintenance. Equipped with a high level of computing power and capable of in-depth analysis, this tool correlates maintenance activities with digital operations data in order to plan maintenance with precise information. It has easily changeable filters – pumping, turbining, operating range, etc. – that can be used to target specific analyses and operations.

WINN is the new nuclear engineering IT system control room that was launched in 2018. Like a control tower, it supervises the overall health of applications in real time and makes daily tasks easier for users.

SWITCH aims to help nuclear engineering become more digital, agile, industrialised and collaborative in order to make major industrial projects and the French nuclear industry safer. EDF has chosen Dassault Systèmes to provide a PLM solution, harnessing its 3DExperience technology. Meanwhile, Capgemini is offering guidance throughout the transformation and integrating Dassault's solutions into the engineering IT system. The goal is to digitise all processes and engage in an entirely data-centric approach, without compromising current projects.

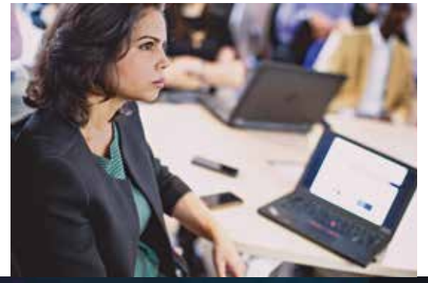
Digitising facilities and analysing large amounts of data helps optimise preparation for operations and makes major industrial projects, such as the *Grand Carénage* programme or end-of-life plant decommissioning, safer.

— Wind and solar: digital monitoring. EDF Renewables has three Operation Control Centers (OCC) in Emden (Germany), Colombiers (France) and San Diego (United States). The teams at these sites constantly monitor generating plants and alarms and intervene remotely at electrical substations and wind and solar farms in order to limit the duration of shutdowns. All of the assets held by EDF Renewables Services in Europe are also now monitored by the Production Data Control Center, whose teams monitor production data in real time in order to identify losses of information and guarantee that information about facilities is reliably reported in the database and particularly in the new digital platform, RED.

— European digital monitoring: predictive maintenance. Inspired by the regional e-operation centres set up for EDF hydropower plants, the European e-Diagnostic Centre was created to develop predictive maintenance. Its teams analyse and track machine performance to detect weak signs of failure so that they can anticipate breakdowns, streamline interventions, avoid breakages and, ultimately, limit shutdowns. At the end of 2018, this implementation of predictive maintenance had saved almost 1,000 days of generation, representing an annual saving of €650,000. Three hundred models have been developed, each corresponding to a number of detection algorithms.

“My role at SoDATA, the new department that creates value from data, involves getting the data collected since EDF’s creation in 1946 to speak. Today, big data helps us innovate and imagine multiple scenarios, so that we can make the right decisions. We can find out exactly when a particular nuclear unit will be available, for example. My team and I came up with a mathematical function that uses long timeframes and the specific features of each reactor to precisely calculate the specific moment that they come back onto the network. This data is a bit like a reactor’s fingerprint; we use it for clarification and guidance through any changes that occur.”

Stéphane Ternot,
head of the data scientist team
at SoDATA



"Within the AI group, our work consists of analysing different types of data (images, text, time series, etc.) in order to create value for the EDF group's business lines. We can, for example, produce forecasts, make finding information easier, and automate certain activities. It's a new name, but I think that data scientists are a new form of statistician. With the explosion of data and low-cost computing power, the use of artificial intelligence is currently producing promising results. IT is taking a key role in our profession."

Aliénor Grandclément,
engineer and data science and AI specialist at EDF

The people behind the technology. Technology cannot do everything. Even if a new technology is reliable, it will not necessarily be integrated correctly. The inability of many industry demonstrators to get past the prototype stage is proof of this. Too often, people make the mistake of seeing the digital transformation solely from a technological point of view, when it is also a transformation in terms of organisation and culture. And yet, work stations are adapted, new responsibilities created and, sometimes, human analysis replaced by algorithms. We must therefore be careful in how we train operators and other employees in preparation for these changes. The ability to adopt new managerial approaches, bring about cultural changes and accept failure will make this digital transformation a success. New roles – such as chief data officers, data scientists, cybersecurity experts and machine learning experts – are emerging, and employees need to be trained in order to take them on. The EDF group just created the *Académie du numérique*, a digital academy that provides training in these new areas of expertise. The academy is part of the Group's digital roadmap initiated by the Executive Management team, the progress of which is assessed through 52 indicators that are updated twice a year. They measure, for example, the number of megawatts tracked through digital monitoring for EDF Renewables, digital twin studies and orders made through e-procurement. Technological priorities have been identified – such as AI development, data exploitation, IoT and the use of blockchain – with the support of Group R&D across an entire extended family of partners and departments for innovation and entrepreneurship.

The ability to adopt new managerial approaches, bring about cultural changes and accept failure will make this digital transformation a success.

Interview

“We are going to transition to a system mixing different energy sources. Digital technology is essential for us to manage smaller but increasingly diverse volumes.”

Serge Abiteboul
IT engineer, researcher and member of the French agency in charge of telecommunication regulations (ARCEP).

Serge Abiteboul has been studying the impact of digital technology on the structure of societies for a number of years. Could an ethical approach become a requirement? According to him, yes – as long as human responsibility is kept at the heart of the debate. Read on for more details.

— Terms like “artificial intelligence” and “algorithms” are dominating conversations at the moment, evoking hope, but also fear. How can you explain the odd relationship – of attraction, but also suspicion – that we have with these technologies?
Serge Abiteboul: First of all, they are just words, which means that we can define them. What is an algorithm? A set of rules that can be used to solve a problem. When people started making bread, for example, they asked themselves a series of questions and made numerous attempts before finding the right amounts of water, yeast and flour. The recipe for bread is therefore an algorithm. There’s no reason why we should be afraid of that. Next, what is artificial intelligence? That’s a more complex concept. A computer carrying out a task that requires intelligence when carried out by people could be described as artificial intelligence. So why do these words make people feel scared and powerless? I think it’s because we lack a culture of technology. We use increasingly enhanced and complex devices, without understanding how they work. They come into our lives and make things easier, like magic. But there is a fine line between magic and black magic that we are often tempted to cross.

— So, we’re sort of under its spell?
S. A.: No, because we are the ones who created this complex technology. You can’t put a spell on yourself. People remain indisputably in control. We can decide, before using a machine or technology, if it is useful in a specific situation. But it’s true that we are currently seeing a contradiction – users want new apps on their smartphones, so they click “install”, give access to their data, then complain when that data is used. But the decision is still up to people to make. We can judge the value of a specific technology and its impact on society. Basically, we can take responsibility.

— Is an ethical digital world possible?
S. A.: Of course. In any case, we have to look at these questions from an ethical point of view. Algorithms are now an integral part of city life. Our job is defining their exact role and impact. As I was saying, when it comes to technology, we are in control, which means that we can place limits on algorithms. For example, we can impose transparency requirements on algorithms by programming them to justify the decisions they draw from their calculations, preventing them from functioning in an opaque manner.

— Do we need legislation to guarantee this ethical aspect?
S. A.: Legislation is of course one of the essential solutions, as we have seen with the General Data Protection Regulation (GDPR). But we have to pay attention to how we legislate and on what basis, and the discourse surrounding it. The government can’t decide by itself, and neither can companies. Civil society, whether associations or individuals, must get involved. I genuinely think that civil society holds the solutions to many of these issues.

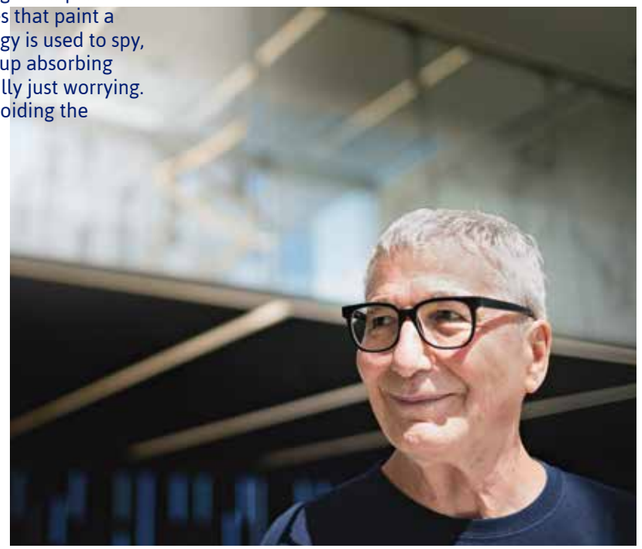
— What role can digital innovations play in a crucial area like the energy transition?
S. A.: IT, in its broadest sense, offers many solutions to this issue. Looking at the bigger picture, the world is becoming more and more complex. Airports, hospitals and public services currently rely on highly sophisticated systems to function. For a long time, the people in charge of them tried to accompany this development by centralising information and systems for production or management. But this view is now reaching its limits. Thanks to IT, we can work accurately, focus on details and move away from the idea of excessive centralisation. You are probably wondering what all this has to do with the energy transition.

— A bit, yes.
S. A.: It’s because we are going to transition to a system mixing different energy sources – nuclear, solar, wind, hydropower, etc. We will therefore have to accurately manage smaller but increasingly diverse volumes. Digital technology is essential in this scenario. The same can be said of home automation solutions. The Internet of Things could change everyone’s relationship with energy because it allows us to better understand our consumption and be accountable. So, you see, we’re back at responsibility. Looking at technological progress and digital innovation, the idea of responsibility is absolutely key.

— Responsibility is therefore key to going from suspicion to trust.
S. A.: Exactly. Without forgetting something else that I think is essential – making the whole idea of technological progress a positive one. There are now countless novels, films and TV series that paint a picture of an apocalyptic future where digital technology is used to spy, oppress and control. Younger generations are growing up absorbing these works, which are sometimes interesting, but usually just worrying. Science should allow us to imagine the future, while avoiding the pitfalls of idealism or pessimism.

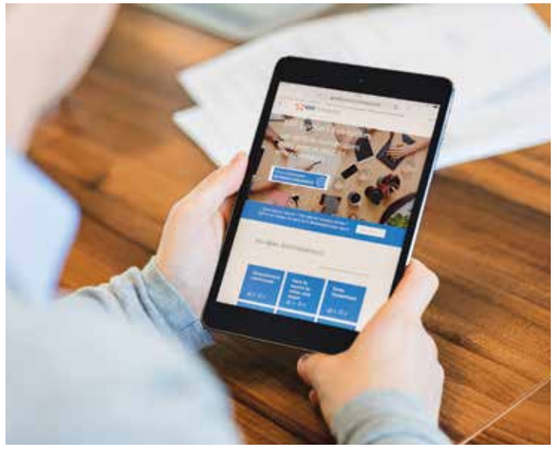
“With digital innovation, people remain in control.”

Serge Abiteboul



Customers:

NEW USES, NEW EXPERIENCES



Could digital technology help us all take ownership of our consumption? Solutions to increase energy efficiency and help people consume better and less are increasing, driven by digital technology and the rise of data, against the backdrop of a social movement to consume less energy. And it is also an economic issue.

How can we become more proactive in how we consume energy and even help balance the grid? Self-sufficiency is on the rise; 4 million homes will produce their own electricity between now and 2035.(1) Nevertheless, EDF's ability to collect and interpret hundreds of thousands of pieces of data will be decisive in simplifying the new complexity of electricity usage. Working closely with customers, we will combine the deployment of new equipment (photovoltaic panels, batteries, electric vehicles and home automation solutions) with an intention to optimise usage and the possibility of using it to contribute to the overall balance of the grid, managed by RTE. The development of smart meters is a core part of this new electricity system. They enable customers to monitor their energy consumption more regularly and easily, as well as access tools to help them save money.

EDF has therefore developed a range of digital services and solutions for both residential and professional customers to simplify their administrative procedures, provide explanations and give customised advice according to how they use energy, and even optimise the management of major energy usage.

An omnichannel approach for greater responsiveness. In just a few years, digital channels have taken a key position in both prospecting and sales, as well as day-to-day customer relations. In France, EDF has become a major online vendor and although the company no longer has physical stores for individuals to visit, customers can obtain information and advice by telephone. EDF advisors, all based in France, answer roughly 1.5 million customer calls every month. The company is taking a "phygital" approach to enhance the customer experience and facilitate communication. EDF aims to provide the perfect balance between people and digital channels, to boost the satisfaction of current and prospective customers and give them the means to contact EDF when, where, and how they prefer. Everything is therefore set up to offer seamless navigation between the different channels of communication and track requests from start to finish, no matter how they are made – i.e. by email, telephone, online form, etc. EDF therefore intends to combine the power and agility of digital technology to process customer requests in a more responsive and effective manner. Artificial intelligence, for example, is used to automatically and accurately transfer 90% of the 40,000 emails received every week to the company's expert advisors.

Digitisation of the business lines is underway. Driven by the digital roadmap, the digitisation of the processes of EDF's business lines has already taken a significant role in the company's activities. The Group is launching a number of projects to simplify and digitise its internal processes, with the aim of making day-to-day life easier for employees and improve performance. This is the case, for example, for purchasing processes, with the development of e-procurement (online catalogue shopping carried out directly by users), paperless orders (250,000 fewer paper invoices by 2020) and supplier invoices (40% paperless in 2019). Another area for optimisation is the development of a unique electronic signature at Group level. At the end of 2019, all authorised employees will have access to a shared electronic signature tool, based on certificates for external authentication and an electronic signature book.

(1) Source: RTE

80%

of people in France are paying greater attention to the impact of products they buy.(1)

10 million
unique visitors to the EDF residential customer websites every month.
Source: F. Gonczi, Chief Digital Officer at EDF

Two out of three of EDF's business customers are active users of their customer account spaces.

46% (1)

of the population aged 12 and over mostly access the internet via smartphone (four points up from 2017).

27 million

electronic invoices issued by EDF in 2017 (out of a total of 156 million).

31% (1)

of people find the internet difficult to use (14 points down from 2017). Of them, 40% want to take training.

30 million

people provided with lighting worldwide through MUSE® by Citelum.

25% (1)

of people in France feel reassured by the entry into force of the GDPR in May 2018. Yet, despite their concern, the majority are not prepared to pay for data protection services.

When digital technology boosts revenue.

Although digital technology is a tool for business, harnessing all of the data to which EDF has customer consent to use, it also makes it easier for new players to emerge in the value chain, ramping up competition. As a result, well-established names are looking for ways to boost growth, particularly by increasingly positioning themselves as providers of services in addition to energy. The new Izi by EDF service, for example, is a digital platform that connects independent tradespeople with individuals and businesses looking to carry out odd jobs or renovation projects. A source of savings and efficiency, digital technology can also offer the ability to create new growth drivers, based on new economic models. Over the last few years, the EDF group has developed a number of innovative customer-focused activities to generate new revenue. There are a great number of fields for development, such as smart lighting, energy efficiency solutions for buildings, and connected homes. MUSE®, designed for urban areas, is a particularly persuasive example. This collaborative management platform that provides smart lighting and connected services in public spaces, marketed by Group subsidiary Citelum, is now operational in cities all over the world. It was set up in Dijon in 2018, for example. Another solution, iBoard, was designed for commercial buildings and is provided by NetSeenergy, the real estate, energy management and IoT specialist. The service consists of an interactive dashboard that can be used to control energy consumption in commercial buildings. Another example is Edelia, who implement solutions to monitor and control energy consumption for residential and professional customers. The company operates a digital platform that enables over 10 million EDF customers to benefit from a range of innovative digital solutions, including in the field of connected homes.

EDF uses its extensive experience in cybersecurity to ensure the highest quality data protection in all of these solutions.

60,000

connected devices read remotely every day (iBoard by NetSeenergy).

(1) Source: "Baromètre du numérique 2018", a study of 2,214 people representative of the population over 12, carried out by the French living conditions research centre CREDOC in June 2018 and published by the French government's digital agencies, Agence du Numérique and Mission Société Numérique

e.quilibre
Customers can get a better understanding and obtain information more regularly and easily in order to be more proactive in their energy consumption by using the e.quilibre features integrated into the EDF "MyAccount" section. The EDF & Moi app also includes a news feed for customers whose homes are equipped with a Linky meter, which alerts customers of their energy consumption in kWh and euros, so that they can change their usage and save money.

Sowee
For customers that use energy in a number of new ways (with connected homes, photovoltaic panels, electric vehicles, batteries, etc.), EDF has designed Sowee, a connected station with a voice assistant that can be used to manage energy usage all over the house – and beyond!

Feelpro
Small businesses can use Feelpro, a digital electricity management tool that adapts its advice to their sector. The owners of shops, bakeries and restaurants can all therefore analyse their energy consumption, get advice and use an action plan to reduce their electricity bill.

A 100% DIGITAL SERVICE

At the end of 2018, EDF launched its first 100% digital electricity contract, for residential customers who want to sign up and manage their contracts exclusively online.

iBoard by NetSeenergy
With iBoard, a solution for smart buildings, companies can monitor and optimise their energy consumption. A digital platform that can be used anywhere and at any time, via website or mobile application, iBoard informs users of their consumption of electricity, water, gas and heating across multiple sites in real time, alerting the person in charge of energy if it goes over the contracted amount.

MUSE® by Citelum
MUSE® is a collaborative management platform for public areas. It helps cities make decisions about how to become more energy efficient, plan maintenance operations, and automatically manage public lighting and road traffic. Intersections, for example, can be controlled remotely for smoother traffic flows and to manage priority between public transport and personal vehicles.

CURRENT ELECTRICITY PRODUCTION
70% of the global electricity mix came from fossil fuels in 2017.
Source: World Energy Outlook 2017, International Energy Agency

40% of the world's electricity generation will come from renewable sources in 2040.
Source: World Energy Outlook 2018, International Energy Agency

IS A DIGITAL REVOLUTION A PREREQUISITE FOR THE ENERGY TRANSITION?

With the rise of renewable energies and the emergence of new uses such as self-sufficiency, electricity storage, smart buildings and electric mobility, the electricity system is set to undergo a major shift in the coming years. In France, these changes are part of the national Low-Carbon Strategy and Multi-Year Energy Programme. The main issue is stabilising frequency across the network.

22.7%
OF ELECTRICITY CONSUMED in France in 2018 came from renewable energy sources.
Source: RTE annual report 2018

70%
of the world's population will live in cities in 2050.
Source: UN

A new order for networks. What was once a one-way supply of energy from power plants to consumers is now becoming an extended network with a greater number of sources of electricity generation. As renewable energies rise in popularity, electricity generation is becoming increasingly decentralised, personalised and widespread. The industry's stakeholders, once numbering dozens, have now risen to hundreds. In the future, they will be thousands, if not millions, should self-sufficiency become more accessible. Integrating these newcomers without destabilising the electricity grid is the key challenge. RTE and Enedis, the entirely independently managed and regulated EDF subsidiaries in charge of the high-voltage and low-voltage networks respectively, must adapt to this new situation – that of a network partially supplied by intermittent and increasingly decentralised energy sources. This is where digital technology has an important role to play. It makes electricity more flexible and enables wide-scale integration of renewable energy without necessarily having to build new infrastructure. It also improves predictive maintenance of the network and encourages everyone to consume less energy.

Smart grids on the rise. Smart grids such as Flexgrid, Smile and You&Grid are dynamic networks that collect and process vast amounts of data quickly and effectively. They must

Selling renewable energy generation for the best possible price

Agregio, a local optimisation platform, is an aggregator that works with providers of electricity from renewable energy sources and corporate customers that are able to carry out load management. The energy providers secure their income by limiting the impact of price and generation fluctuations on the value of their electricity, and the customers are compensated if they agree to adjust their consumption according to the needs of the electricity system. Agregio uses its own virtual connected platform to coordinate the generation, consumption and storage of customers' industrial facilities in real time. It is therefore playing a role in the rising popularity of renewable energy by helping providers navigate electricity markets and giving greater visibility to investors.

simultaneously facilitate the connection and operation of all generating plants, allow consumers to play an active role and increase the reliability and resilience of the electricity system. In short, they are key to the energy transition. Smart grids facilitate the integration of renewable energy into the network, as well as the use of decentralised and intermittent energy sources and unpredictable consumption such as electric vehicle charging and heat pumps. They can regulate spikes in usage and avoid the need for more expensive energy generation that produces higher levels of greenhouse gases. Stakeholders in France are currently creating a network of smart grids, with a number of demonstration projects throughout the country. Aside from their role in the energy transition, these grids are building an industrial sector for France's future, creating 15,000 jobs nationally.

Virtual lines and power plants. To make the grid more flexible and fill in the gaps in intermittent energy generation from renewable energy, the French electricity transmission network operator, RTE, is experimenting with virtual lines, using powerful batteries to alleviate certain types of congestion. The project, named RINGO, consists of using various storage methods in different locations throughout the grid to reduce transmission in a particular area for a certain amount of time without destabilising the balance between supply and demand.

During a peak in wind power generation, batteries temporarily store excess energy before it is released further down the line. This solution avoids the need to build additional lines while maximising renewable energy generation and existing lines.

Successfully combining water and the Sun. In southeast France, a virtual power plant called So FLEX'hy – a portmanteau of the French word for the Sun and flexibility and hydropower – has been developed. It provides a solution to the intermittent nature of renewable energies, using the wealth of energy available in the Alpes-de-Haute-Provence department, which boasts wind turbines, solar farms (in Manosque, Sainte-Tulle and Les Mées) and around ten hydropower plants along the Durance and Verdon rivers. When there is sudden cloud cover or the sun does not come out to shine, So FLEX'hy automatically commands the hydropower dams positioned on these rivers to make up for the drop in photovoltaic electricity. In less than ten minutes, the electricity generated by these dams is injected into the grid, with no power outages. The cohesion between renewable energy and this coordinated and automatic management prevents grid congestion when the sun suddenly comes out and creates a massive injection of electricity. The financing and installation of new electricity lines in the area will also help relieve congestion.

1.2 MILLION
privately owned electric cars in France between now and 2023.
Source: the French Multi-year Energy Programme

7 MILLION
charging stations for electric vehicles in 2030.
Source: Enedis website

An energy mix made up of around **50%** renewable energy by 2035.
Source: the French Multi-year Energy Programme

4 MILLION
homes expected to be self-sufficient by
2035.
Source: RTE

2.5 MILLION
homes retrofitted in France in 2023 (major or deep retrofits).
Source: the French Multi-year Energy Programme

Almost
300,000
pieces of data are currently processed by RTE in real time.
Source: RTE

Interview

“Digital technology is making us ask really profound questions related to the founding principles of our societies.”

Françoise Soulié-Fogelman

A specialist in data mining(1) and big data and teacher of computing, Françoise Soulié-Fogelman taught a course on artificial intelligence at Tianjin University in China, and is now one of the experts chosen by the European Commission to devise a strategy in this field.

(1) Data mining: extracting insights from data

Françoise Soulié-Fogelman recently taught a course on artificial intelligence in China for three years. She is now one of the experts chosen by the European Commission to devise a strategy in this critical field. For her, the digital revolution and ethics are inextricably linked and form part of an essential discussion about the future of our societies. Is democratic, inclusive and privacy-sensitive AI possible? Françoise Soulié-Fogelman answered our questions.

— We find ourselves today at the dawn of a complete revolution of our way of life that is being driven by artificial intelligence, and...
Françoise Soulié-Fogelman: Can I just interrupt you to talk about that for a second?

— Of course!
F.S.-F.: I just wanted to specify that artificial intelligence is nothing new – it's not even the beginning. Let's look at the history of this technology – or, rather, these technologies. Because there are basically two types of AI. First of all, there's symbolic AI. People input strings of logical rules into machines, which memorise these rules in order to make decisions. Then there's connectionist AI, in the form of deep learning and neural networks, which is based on the computing power of algorithms using simple data input into the machine. These two groups have existed since 1955. So, you see, it's not really new. When we look things up on search engines or make online purchases, we are surrounded by AI; we are already living with it. But it's true that, over the last few years, connectionist AI has totally overshadowed the symbolic approach and brought us into a new age.

— Why?
F.S.-F.: 2012 was a turning point. That was when the Canadian researcher Geoffrey Hinton took part in the ImageNet competition (Ed.: a competition where the goal is to make computers accurately recognise and classify objects and scenes), improving the usual scores by 15% through the use of deep learning techniques, when conventional techniques could only improve them by 1% or 2%. Connectionist AI therefore established itself as the more effective approach. From then on, the amount of data has just exploded. It's important to note that in 1985, algorithms did exist – but data was much rarer. But with connectionist AI, the more data available, the more effective the algorithm. The combination of constant technological progress and the exponential growth of data is amplifying the potential of AI.

— The combination of algorithms and big data marks a new step that is raising many questions today, particularly from an ethical point of view. What do you think about these concerns?
F.S.-F.: They seem to me to be absolutely essential. Data can be used in a good or bad way. Ethical questions are therefore core to digital and should not be forgotten. We have to order AI to follow certain principles, so that we can trust it. But which values do we think are indisputable? Many European Union member countries would say democracy, the fight against discrimination and the protection of personal freedoms. But other countries such as China, for example, don't have the same relationship with these ideas, due to their history and culture.

— Beyond these principles, how do these differences manifest in reality?
F.S.-F.: Let's look at a specific example. China has a social credit system. All of the information – purchases, trips and financial situations, for example – collected about an individual is used to establish a scoring system, which gives – or takes away – their access to services, products, etc. Most of us are shocked by this system. The same goes for facial recognition, a procedure that is more readily accepted in China. Digital technology is therefore now making us ask really profound questions related to the founding principles of our societies. That's why decisions of this magnitude should be taken at the European level in order to really bear fruit. Particularly in terms of budget – the EU can make sizeable investments (it aims for €20 million per year), which means it can compete with major powers like the US and China. The EU has chosen a slogan that perfectly sums up its position: AI for good and for all. "For all" – that shouldn't be forgotten. Digital technology should contribute to social cohesion, and not just be available to the most privileged. That's also a really firm ethical stance.

— Ethics usually means setting limits. But aren't limits, by definition, barriers to innovation?
F.S.-F.: I don't think so. Of course, our values have a "price", of sorts. Any product that respects more principles complies with more constraints. It is therefore more expensive and, in the short term, less competitive. But taking a long-term view reveals a far less simplistic situation. A product designed according to ethical guidelines will also be more reassuring, convincing and, ultimately, more popular. The implementation of the GDPR in Europe has been very enlightening. There was widespread criticism at first – "this bill will destroy companies", "it's the end of innovation", etc. And yet, Silicon Valley and China are now addressing ethical issues and looking at the GDPR with great interest. The moral approach to digital technology is a way of stimulating innovation and investing in the future, not a barrier.

— How can we make consumers truly understand the importance of these ideas, so that they can take them into account in their choices?
F.S.-F.: Through education. IT is finally going to be studied at sixth form in France, and there's no question that this will be the best way to raise young people's awareness of the issue of data usage. The four biggest tech companies – Google, Amazon, Facebook and Apple – built their success not only on their ability to innovate, but also the public's lack of knowledge about data usage. But people are beginning to wake up, and will continue to do so. This is just further proof that consumers will increasingly take ethics into account when choosing a digital service or product.

"The ethical approach stimulates innovation."

Françoise Soulié-Fogelman

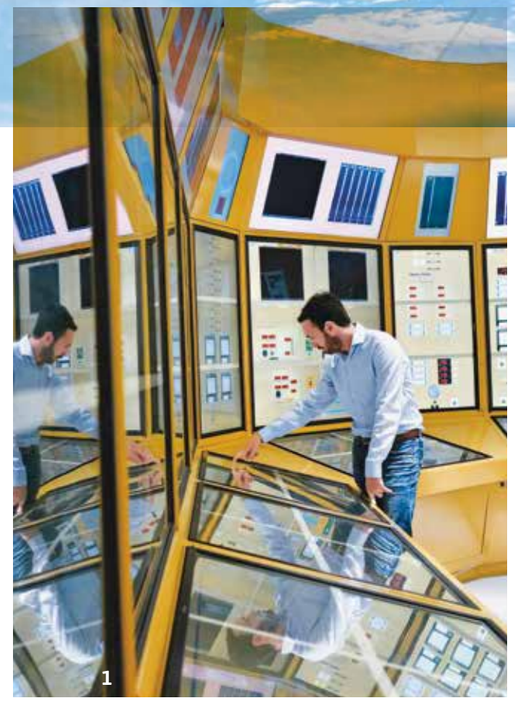
ARTIFICIAL INTELLIGENCE

Could we cope without it?

Artificial intelligence – in the form of self-driving cars, robots, machine translation, predictive systems, chatbots and more – is already everywhere. It can be found in factories, research centres and entire cities, as well as in our homes and in all the application programming interfaces (API) that we use on our smartphones every day, inundating us with suggestions. With AI, everything is smooth, simple and "smart" – as long as it is regulated and used to help people and make progress.

With algorithms, AI can be used to build systems that act increasingly independently, considering and communicating with their environment, reasoning, taking action and, at the same time, learning and improving. They are, for example, capable of solving complex problems that cannot be addressed by conventional IT systems, and adapting to uncertainty. All this is made possible by the almost infinite computing power of the cloud, as well as the huge amounts of data now available. Recent advances in deep learning, a system of learning through repetition, have led to major success stories – in image recognition, for example – but there is still a long way to go.

AI, a key topic for the future of R&D. At EDF, AI is used everywhere: in industrial activities, customer relations, energy management and internal processes, it is used to carry out predictive maintenance, offer enhanced advice, forecast consumption for the management of connected homes and, in the future, optimise the performance of electrical vehicle fleets. With more than 40 data scientists in the Data Innovation Lab, the Group's R&D activities particularly focus on data science, a field that aims to extract insights from numerical data.



1

2

1. Industrial performance. Metroscope uses an AI system to provide industry customers with diagnostics in real time, so that they can increase or optimise the performance of their facilities by identifying risks, breakdowns and yield loss affecting their operating systems. Chosen by the Executive Management of EDF's nuclear fleet, this solution has been deployed across all 58 nuclear power plants in France. Meanwhile, the GECKO data analytics system uses automated text analysis to harness feedback contained in the many documents accumulated in over ten years of nuclear operation.

2. Energy efficiency. EDF subsidiary Dalkia has set up Dalkia Energy Saving Centres (DESC), interactive platforms that can be used to control the consumption of energy installations in buildings. Dalkia is also working on an app that gathers all of the energy data for each site. The app uses AI algorithms that make it easier to identify deviations in performance and target sites to be addressed as a priority.

3

3. Customer acquisition. EDF is carrying out major data analysis as part of its ARIA (the French acronym for automated robot artificial intelligence) project launched by EDF Commerce, in order to better understand which services and products are most likely to interest prospective customers. With this aim in mind, the Group approached the ZenWeShare[1] start-up, which uses AI to optimise customer relations. In just a few seconds, their algorithm allows websites to adapt their interface in real time according to every visitor's profile and how they use the internet. The solution finds out, for example, what a prospective customer or visitor's preferred channel of communication is and which subjects they care about in order to contact them in the most appropriate way afterwards.

(1) ZenWeShare is now called Dokati

4

4. Daily well-being. Thanks to the emergence of IoT, AI can now be found in every room of the home. It uses sensors that are gradually moving into our households. Examples of this are occupancy sensors and connected thermostats that, when linked to heating systems, regulate and control the temperature. In addition, connected speakers and smartphones contain applications, which all require AI to function. EDF's connected station Sowee, for example, uses Amazon's voice assistant, Alexa, to enable customers to manage the comfort of their homes.

5. Making work comfortable and supporting business lines. AI has eliminated the need for people to carry out many repetitive and tedious daily tasks. Many websites now offer instant chat features where, when a question is asked, an answer appears a second later. This is, in fact, the work of a computer program that collects all of the possible questions people may ask and related words in order to provide a suitable response. At EDF, AI is already widely used to streamline internal processes and interactions with customers, suppliers and Group employees. This is the case, for example, of the legal department chatbot, which is capable of answering almost 6,000 questions and helping employees write contracts by themselves. Other initiatives are cropping up elsewhere in the company, such as in the accounting department, which uses robots to automate account reconciliation and check invoices created by producers of renewable energy that EDF purchases. The department also has the Agathe bot solution, to automatically process supplier emails, and ChatOA, to answer questions from small independent producers of photovoltaic energy.

5

DID YOU SAY BLOCKCHAIN?

Rarely has a new technology provoked so much debate, enthusiasm and trepidation so early in its existence. It must be said that blockchain, little known among the general public, is worth stopping and thinking about.

Blockchain affects almost all sectors, including real estate, finance and energy, being a technology that has something to offer for every sector, given the common interest of taking out the middle man, and the emergence of peer-to-peer trading. But what is it exactly? Blockchain is a new way of storing information and preserving it without the ability to make any modifications. It can be accessed and new additional information can be added, but this becomes tamper-proof in turn. The development of blockchain therefore promises radical change for the important security issues encountered in centralised computing systems.

Trust and traceability. Blockchain can be applied in the energy sector in many different ways. For example, it could contribute to the development of collective self-sufficiency and microgrids by solving some of the problems related to transactions between customers and producers in these energy communities. And in the electric vehicle sector, blockchain could facilitate the process of billing drivers for battery charging. In this scenario, the transaction amount would be automatically taken from their account via smartphone to pay the electricity provider or operator of the charging station. In May 2019, the French financial institution Caisse des Dépôts, EDF, Engie and the national postal service La Poste announced the joint development of blockchain infrastructure to simplify and secure information related to both individuals and companies. This infrastructure will simplify identity verification processes, enabling those concerned to access their data. The platform, named Archipels, will first offer a certification service, providing customers with a solution to guarantee the authenticity of invoices and other similar documents.

How are blockchain technology and energy connected? Designed to manage cryptocurrency and protect transactions, blockchain is making its debut in the energy sector. We spoke to Gilles Deleuze, a senior researcher at EDF's R&D centre in Saclay.

Is blockchain a long-term change, or just a bubble?

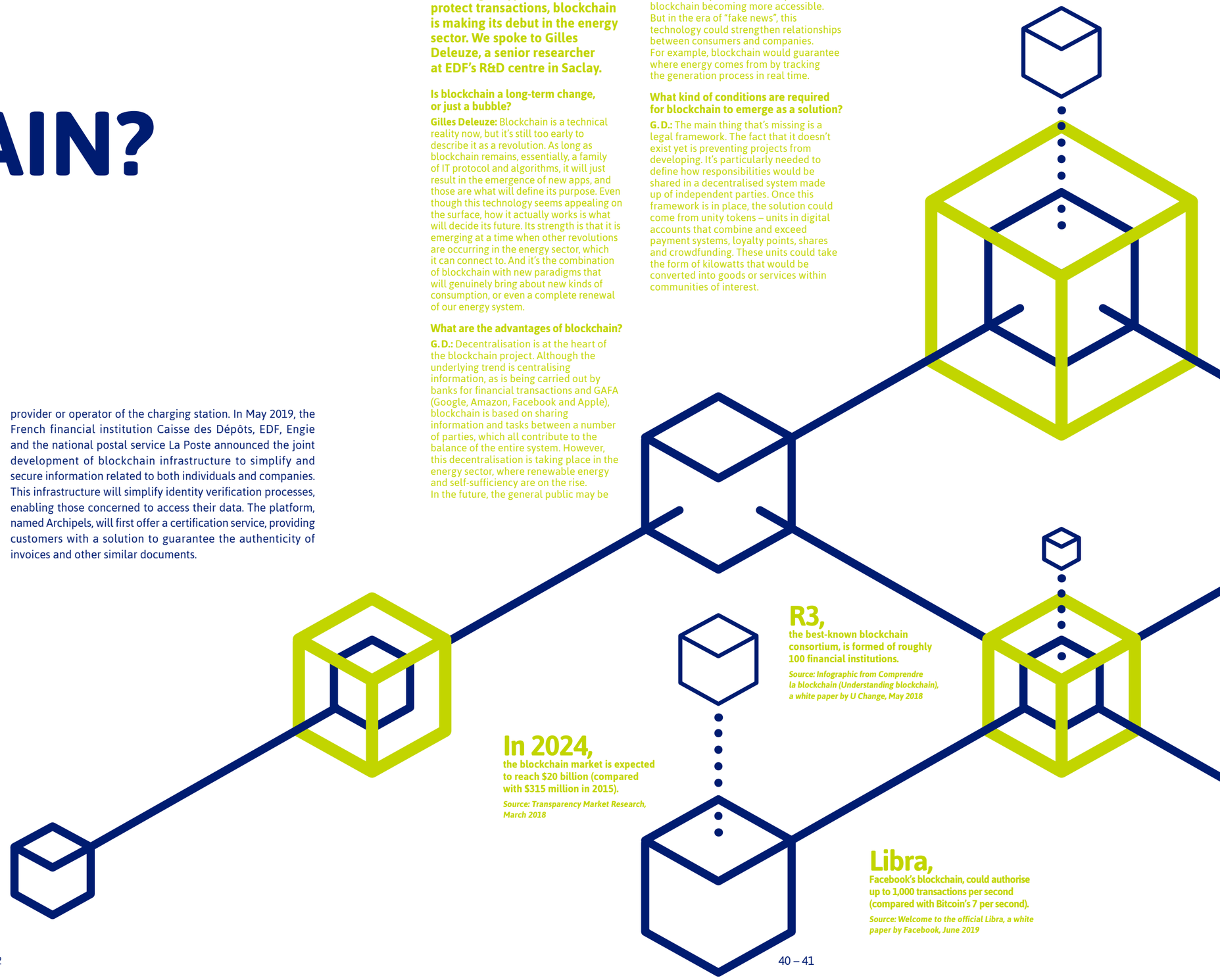
Gilles Deleuze: Blockchain is a technical reality now, but it's still too early to describe it as a revolution. As long as blockchain remains, essentially, a family of IT protocol and algorithms, it will just result in the emergence of new apps, and those are what will define its purpose. Even though this technology seems appealing on the surface, how it actually works is what will decide its future. Its strength is that it is emerging at a time when other revolutions are occurring in the energy sector, which it can connect to. And it's the combination of blockchain with new paradigms that will genuinely bring about new kinds of consumption, or even a complete renewal of our energy system.

What are the advantages of blockchain?

G.D.: Decentralisation is at the heart of the blockchain project. Although the underlying trend is centralising information, as is being carried out by banks for financial transactions and GAFA (Google, Amazon, Facebook and Apple), blockchain is based on sharing information and tasks between a number of parties, which all contribute to the balance of the entire system. However, this decentralisation is taking place in the energy sector, where renewable energy and self-sufficiency are on the rise.
In the future, the general public may be responsible for energy management. Although self-sufficiency is a possibility for some, opening it up to the masses is still some way off. It would require blockchain becoming more accessible. But in the era of "fake news", this technology could strengthen relationships between consumers and companies. For example, blockchain would guarantee where energy comes from by tracking the generation process in real time.

What kind of conditions are required for blockchain to emerge as a solution?

G.D.: The main thing that's missing is a legal framework. The fact that it doesn't exist yet is preventing projects from developing. It's particularly needed to define how responsibilities would be shared in a decentralised system made up of independent parties. Once this framework is in place, the solution could come from unity tokens – units in digital accounts that combine and exceed payment systems, loyalty points, shares and crowdfunding. These units could take the form of kilowatts that would be converted into goods or services within communities of interest.



R3,
the best-known blockchain consortium, is formed of roughly 100 financial institutions.
Source: Infographic from Comprendre la blockchain (Understanding blockchain), a white paper by U Change, May 2018

In 2024,
the blockchain market is expected to reach $20 billion (compared with $315 million in 2015).
Source: Transparency Market Research, March 2018

Libra,
Facebook's blockchain, could authorise up to 1,000 transactions per second (compared with Bitcoin's 7 per second).
Source: Welcome to the official Libra, a white paper by Facebook, June 2019

For companies,
data is a strategic asset – both
a driving force and raw material
to create value.

DATA: A PRICELESS ASSET (FOR COMPANIES)

We distinguish production data from commercial or tertiary data, and energy generation divisions in particular hold a wealth of data. The nuclear sector, for example, intends to use its 2,000 reactor years[1] to reduce the amount of maintenance activities and unplanned shutdowns and increase the yield of its facilities.

A collective resource for producers. EDF intends to use and benefit from this asset by setting up a Group data catalogue and assigning responsibility for it. Launched in 2018, the *Usine Data Analytics pour la Production* programme creates value from data for producers by using AI, data science techniques, big data and, of course, the expertise of the different business lines. The initiative brought together around 20 people with computing, mathematics and high-tech industry skills to the same site. Once collected, sorted and classified, the data can now be analysed, thanks to the computing power of algorithms and the expertise of the data specialists. The programme will help prevent unplanned shutdowns and reduce the costs of certain maintenance operations, and take form in the completion of 20 to 30 use cases per year, such as in the event of steam generator clogging.

A data lake for everyone. Although energy producers are brought together within the *Usine Data Analytics pour la Production* programme, each producer and entity also have access to their own individual data lake. This is the case for tertiary activities, nuclear (which has its own data lake, Espadon, containing hundreds of terabytes of data related to operations and maintenance) and renewable energy, which has RED. This digital platform will bring together all of the information (data related to wind, generation, location, etc.) from the Group's global portfolio of renewables. This means that information about a capacity of over 22,000 MW, spread across more than 20 countries, will be accessible in one place. Being able to access this significant amount of data, in hand with a big data approach, will allow us to better understand how the fleets behave, anticipate irregularities and improve performance, control assets in real time using the conclusions gained from data science, and analyse generation and customers' energy consumption in order to better meet their needs.

And images. Singling out and listing objects in thousands of images is now possible, thanks to Leonard – an algorithm that can analyse images of artificial buildings and single out every component according to category. Made up of two latest-generation deep learning networks, which complement each other to detect almost all components (such as insulation and fire hoses), Leonard makes it considerably easier for engineers to maintain and decommission nuclear power plants.

RED
will bring together all of the information from the Group's global portfolio of renewables.

(1) 2,000 reactor years means that the 58 nuclear reactors have been functioning for a total of 2,000 years since commissioning, therefore producing a huge amount of data

Cybersecurity:

A MATTER OF SURVIVAL FOR COMPANIES

The EDF group is particularly vigilant in implementing a very strong cybersecurity and data protection policy due to its size, the sensitive nature of its facilities and the enormous quantity of data that is has accumulated over the last few decades. The Group implements this policy through its security operations centre (SOC), which can detect and reject any attempt to compromise the IT system. The challenge is threefold, involving combining cybersecurity and responsiveness, ensuring the safety of business line applications and IT infrastructure, and complying with regulations. In order to reduce security-related costs, we are focusing our efforts on how IT is designed. Why? Because the further ahead we are – with integration, testing and production – the more costs rise. Indeed, "security by design" was a core topic at the third Cybersecurity plenary session held by EDF in March 2019.

"Cybersecurity has become a strategic issue for companies because attacks and malfunctions can lead to serious material, financial and human consequences. I am the head of the CYNERGIE project for cybersecurity, innovation and research for the EDF industrial group. Launched at the beginning of 2018, the project brings together cybersecurity experts from EDF's R&D department, the Institut Mines Télécom business school, the laboratory for systems analysis and architecture at the French National Centre for Scientific Research (LAAS-CNRS) and representatives from the Group's different business lines. Together, we are working to develop new techniques that will make our industrial infrastructure safer. Everything changes very quickly in the world of cybersecurity. Attackers always try to stay one step ahead, and we must constantly work to face this challenge."

Youssef Laarouchi,
cybersecurity specialist

The cost of cybercrime

in million of dollars

Source: Les Échos.

€20 million:

the maximum fine for companies that do not follow the rules for collecting and storing the personal data of third parties (see the General Data Protection Regulation, or GDPR).

Source: GDPR

$600 billion:

the annual cost of cybercrime = 0.8% of world GDP.

Source: Center for Strategic and International Studies

40 seconds:

the frequency of ransomware attacks (a technique of preventing access to devices and demanding a ransom to restore it) made on companies in 2017.

Source: Association of Certified Fraud Examiners (ACFE)

Ilan Gracier is a hacker. He hacks into the IT systems of companies, hospitals and government institutions. But he does so with their consent, so that they can strengthen their protection. Gracier is a white hat, or ethical hacker. He talked to us about what he makes of the risks of hacking and signs of hope in our digital companies.

We know that hacking is a threat. But to what extent?

Ilan Gracier: There aren't any official figures or studies, but there's one thing we can be sure of – cyberattacks are increasing. Over the last three weeks (Ed.: this interview took place at the beginning of July 2019), three major cities in the US have been hacked. They then had to pay hefty ransoms to recover their data, not to mention the problems caused by the interruption of multiple public services. Hacking is thriving because it's based on an excellent business model; it's not very expensive (you can buy a decent virus for €20,000 online), payoff is quick, and the market is growing constantly because IT is now central to all organisations. For a hacker, every computer is a potential way in.

You see yourself as a white hat, or an ethical hacker. What does that mean?

I. G.: White hats attack IT systems with the consent of the management of the company or public service in question, but only a few people are aware when we carry out these attacks. We therefore reveal these systems' weak points. Of course, everyone involved needs to trust each other. I started doing this six years ago for the Israeli administration, to show them that their system was strong, but perhaps not as much as they thought. I got involved because it's an important subject that affects everyone. And, to be honest, because it's just as exciting as "bad" hacking, without having to go to the dark side. White hats pay off – after our involvement, clients improve their organisation and practices.

Why are malicious hackers so effective? It seems like they're always a step ahead.

I. G.: It's not about being effective. Defending something is simply much more difficult than attacking. You have to protect every computer and every email every single day, making sure that all employees apply best practice – not an easy task. And hackers, like terrorists, attack when they want, in any place and at any time. They can engage in multiple attempts to reach their goal. The demands just aren't the same.

The more we innovate, the more areas of risk we create, and the more vulnerable we are to hacking. Are hacking and technology intrinsically linked?

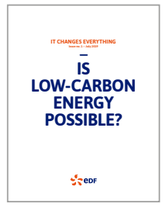
I. G.: I like technology. We can use it to achieve essential progress. But I think it's often just used incorrectly, or naively. Today, for example, you can find all the data you want about someone on Facebook, and just downloading an email attachment from an unknown source can launch a cyberattack. We should all be more aware of the risks, more realistic, and more responsible. But I'm still optimistic. The invention of the car changed the world, drastically changing trade and mobility. But, like all major innovations, it brought risks with it too. Car seatbelts only became widespread in the 1960s. Then came airbags. In IT and digital technology, we currently have too many different seatbelts, and none of them are completely effective. But we'll find the right system eventually.

"For a hacker, every computer is a potential way in."

Ilan Gracier
Ethical hacker

IT CHANGES EVERYTHING

A magazine that addresses the major issues of the energy transition.



Issue no. 1 – July 2019

Issue no. 2 – October 2019

Issue no. 3 – out in December 2019

ÇA CHANGE TOUT

Radio shows exploring and challenging the shift currently taking place in the digital era, with two guests: Françoise Soulié-Fogelman, specialist in data mining and big data, and Étienne Klein, physicist and scientific philosopher.

Interviews with well-known figures and experts that “change everything”.

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EDF 2019 — Issue no. 2

Issue no. 2 – October 2019 **Editorial design:** Communication Division. **Design: HAVAS PARIS. Copyright registration:** ISSN pending. **Author:** Antoine Blachez. **Translation:** Alto. **Illustrations:** Satoshi Hashimoto – Dutch Uncle. **Photo credits:** © CAPA/Alexandre Dupeyron (p. 4, 5, 6, 20, 21, 23, 32, 33, 35), © EDF/ Denis Allard (p. 8, 9, 12, 13, 14, 15, 17, 18, 19, 38, 39, 44, 46, 47), © EDF/Marc Caraveo (p. 16, 17, 43), © EDF/Adrien Daste (p. 27, 39), © EDF/Jean-Lionel Dias (p. 16, 24, 29), © EDF/ Philippe Eranian (p. 45), © EDF/François Fèvre (p. 37), © EDF/Lewis Joly (p. 8, 9), © EDF/Guillaume Murat (p. 27), © EDF/Alexis Morin (p. 14, 15, 45), Getty Images – Narvikk – iStock (p. 46), © EDF/Jean-Luc Petit (p. 42, back cover), © EDF/Xavier Popy (p. 10, 19, 30, 37), © EDF/Christel Sasso (p. 27), © EDF/Solis Images – Shutterstock (p. 25), © Getty Images / bgfoto (p. 37) / Valery Inglebert – EyeEm (p. 28, 29, 31) / ooyoo (p. 38) / Pixelfit (p. 27) / Xinzheng (p. 8, 9).

Is the rise of digital bringing about a new industrial revolution?

Yes - and the proof lies in the fact that industry 4.0 is already involved in a number of sectors, including electricity generation. As a result of these technological innovations, we are reassessing how we work with machines and developing new occupations, and our society is undergoing major changes. But are all digital innovations signs of progress for the common good and working towards a better future? This subject is of particular interest to the physicist and philosopher Étienne Klein, while, the general public tend to approach the idea of progress with suspicion or even distrust.

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Could the energy transition happen without digital technology?

According to Serge Abiteboul, IT engineer and researcher, digital technology is essential to managing smaller volumes of energy from increasingly diverse sources such as solar, wind, hydropower and nuclear. It helps us all take greater ownership of our energy consumption. For EDF, digital technology is a golden opportunity to enhance its relationship with its customers and invent new services – driving growth for the Group and saving money for companies, local authorities and individuals. The one condition is that a number of business lines are digitised and employees are supported throughout this transformation.

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AI, blockchain, big data... What can we use them for? And just how mature are they?

As pointed out by Françoise Soulié-Fogelman, a specialist in data mining and big data and teacher of computing, they are "making us ask really profound questions related to the founding principles of our societies." For EDF, the challenges are considerable – as is the amount of data in its possession, which has been gathered in "lakes" in order to optimise the Group's fleet of generating plants. And that data needs to be protected. In this issue, the subject of cybersecurity is addressed by Ilan Gracier, a white hat or ethical hacker.

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The Group is ISO 14001 certified – **October 2019.**