# Accelerating Energy & Environmental Transition in Europe through digital

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Digitalization is becoming ubiquitous in the energy sector, enabling a more decentralized energy system and blurring the traditional energy sector boundaries, with more integration with buildings, mobility solutions and industry. Digitalization is accelerating the pace of the energy transition, mainly thanks to three levers: 1) enhancing customer interaction with the energy system, 2) optimizing operations, and 3) enabling new business models for traditional energy actors as well as opening up space for new entrants from other sectors and energy startups. Digital technologies are also facilitating a cost-effective, clean energy transition, mainly by increasing energy efficiency and flexibility, as well as enabling the integration of renewable electricity into smart(er) grids and developing low-carbon solutions.
This article gives a brief overview of the digitally-enabled innovations in Europe's energy markets and how various players are positioning themselves to take advantage of these opportunities. It concludes by highlighting some of the policy issues this transformation raises and the challenges ahead for European businesses to reap the benefits.

## Energy transition: a fast growing market, enabled by digitalization

The energy transition, which combines the development of renewable energy, energy efficiency, and other low-carbon technologies and services, is likely to be a fast growing market with double-digit annual growth in the next decade. Digitalization (2), which is part of the fifth technological revolution (3) and driven by a combination of technologies such as Internet of Things, Machine-to-Machine technology, advanced analytics, cloud platforms, social networks, mobile apps, or Integrated Energy Management Solutions, will accelerate the energy transition even further.

But not all European countries, market segments or technologies are equally attractive. According to the latest reports from the IEA, Navigant or Technavio and Capgemini Consulting's own studies, the fastest growing energy efficiency markets in Europe will be France, Germany, Italy and the UK, growing by more than 15% a year, while analysts forecast slower growth in Southern Europe. Offices and commercial buildings like hotels, restaurants, and hospitals offer greater opportunities than industrial (4) or residential segments according to these studies.

The digital revolution is enabling the development of smart (5) energy solutions and creating new markets from which European companies can profit. Utilities, energy equipment providers, service providers from different sectors, start-ups and end-users, are all expecting to generate additional value from these new services and cost savings. They also anticipate benefits from lower greenhouse (GHG) emissions.

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*(2) The adoption or increase in use of digital or computer technology by an organization, industry, country, etc. (source: Oxford English Dictionary).*
*(3) The Age of Information and Telecommunications: See C. Perez, Technological Revolutions and Financial Capital: the Dynamics of Bubbles and Golden Ages.*
*(4) The industrial sector is considered more mature, having significantly invested in energy efficiency solutions such as automation or smart metering over the past decade.*
*(5) "Smart" is generally used to refer to an application of digitalisation in the energy sphere (such as smart metering, smart grid, smart home…).*

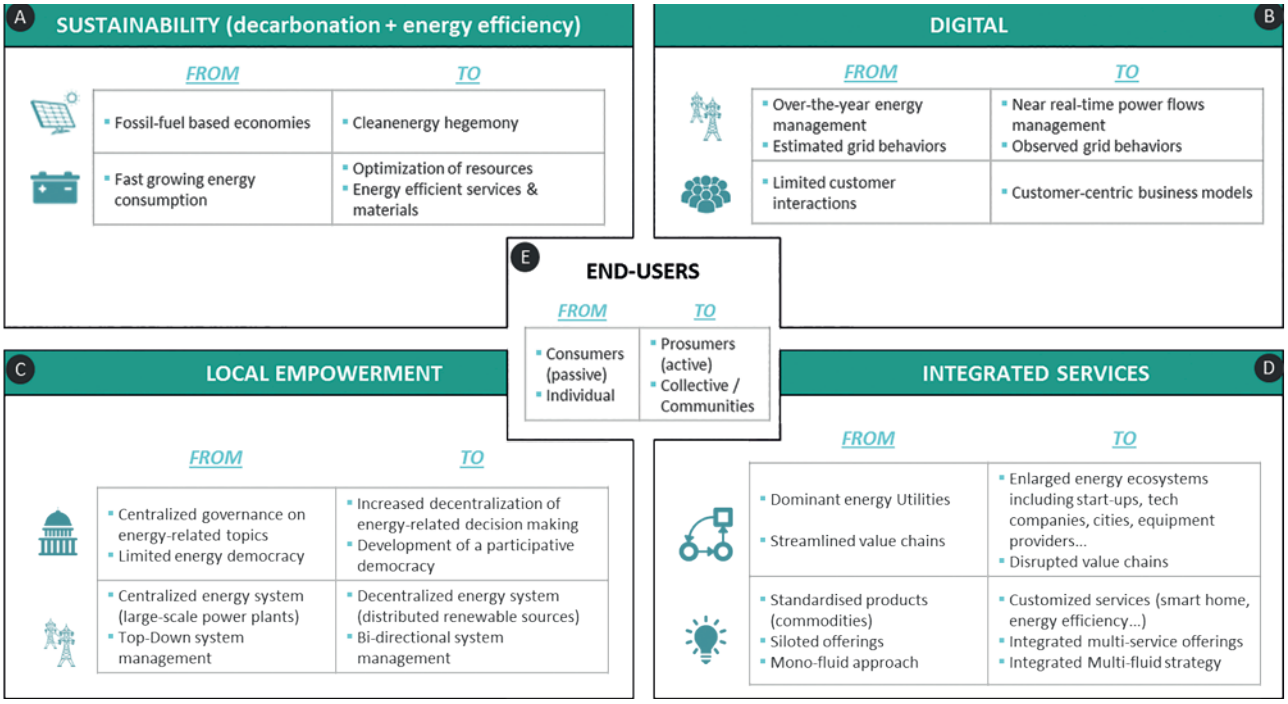


Figure 1: Four megatrends driving the energy transition.
Source: i24c & Capgemini Consulting.

The total value of digitalization for the power sector alone is estimated by the World Economic Forum to be around $1.3 trillion globally between 2016 and 2025 [6].

Digitalization is part of four rapidly emerging, interrelated, megatrends that are profoundly changing the European energy system, along with sustainability, local empowerment, and integrated services (see figure 1).

We observe in most parts of Europe, a paradigm shift towards low-carbon and user-centric economies, driven by digital and integrated flexible solutions putting end-users in the driving seat. New actors, such as electricity aggregators and car-sharing platforms, are putting end-users at the center of decision-making. Even incumbent energy companies are moving from selling electricity or energy equipment to offering services that satisfy customer needs. The "pro-sumer" [7] is now an established feature of the energy system and growing in importance: for instance, private citizens and farmers now own almost half of Germany's renewable energy installed capacity, while in Denmark, private individuals own 85% of its wind turbines. Similarly, crowdfunding and crowdlending [8] are enabling citizens to finance the deployment of renewable projects and energy efficiency measures[9].

If Digital is a key lever of the Energy revolution, it could also be a significant risk: digitalization is a major factor of electricity consumption growth. Digitalization will reduce emissions if this electricity is low-carbon. In addition, rebound effects and the footprint of the required equipment should be harnessed".

**Claire Tutenuit, déléguée générale, Entreprises pour l'Environnement**

## Digitalization is accelerating the pace of the Energy and Environmental revolution, addressing all core aspects of businesses: customer experience, operations and business models

Digital technologies are contributing to the environmental transition across the energy sector (from energy production to transportation, distribution, consumption and associated services). For instance, they are leading to higher efficiency in operations up and down the energy supply value chain, thanks to better analytics, the use of virtual environments [10], the introduction of automation and artificial intelligence. Digitalization is also enabling the integration of renewable energies into smart(er) grids. The various components of the energy system communicate more and more with each other - from electricity generation to transport and storage, and from distribution to consumption. The conversion of electricity meters into smart meters means we can track, in real time, how much electricity has been consumed when and where. All this is bringing about a fundamental shift: supply is geared to demand,

*(6) http://reports.weforum.org/digital-transformation/electricity-generating-value-through-digital-transformation/Significant areas of value are identified as: Asset life cycle management, Grid optimization and aggregation, Real-time supply and demand platforms, Integrated customer services, Beyond the electron.*
*(7) Contraction of "producer" and "consumer".*
*(8) In April 2016, Générale du Solaire (French PV developer) raised more than 1 M€ over 5 days using the crowdlending platform Lendosphere.*
*(9) See also PELLERIN-CARLIN T. and SERKINE P. (2016),* Europe needs crowd-based innovation for a competitive energy transition, *Institute Jacques Delors.*
*(10) Such as remote digital technical centers or cockpits, see below.*

Photo © Daniel Pilar/LAIF-REA

Family farm in Schleswig-Holstein with wind turbine and solar panels.

"Private citizens and farmers now own almost half of Germany's renewable energy installed capacity, while in Denmark, private individuals own 85% of its wind turbines."

but demand also adapts to supply, which facilitates the integration of more non-dispatchable [11] renewable power sources (such as wind or photovoltaics).

Beyond these benefits, digitalization is driving the deployment of new technologies and the creation of new models (digital services platforms, market places, digital communities, connected energy equipment and related services) that could be game-changing as they empower end-users, industry, local communities or regions and make them a more integral and active actor in the energy system. Figure 2 (please see below) illustrates the range of opportunities that digital levers provide to the energy system.

## Digital boosts the customer-side of the energy transition

Traditionally for citizens, energy is a pure commodity, the management of which they do not prioritize because there is no buying or consuming experience. Smart meters and smart homes may help to fill this gap because they make energy visible. Furthermore, digital technologies are people-centric and they progressively enable human beings in their social environment to express their identity via energy. For instance, with residential solar PV comes a social status, which drives adoption in adjacent neighborhoods [12].

Digital has historically been used in the energy industry to improve customer experience, and more specifically to facilitate energy savings through smarter energy efficiency programs, demand-side response, and cross-sector coupling. First, digital vastly increases service providers' ability to interact with customers, using social media, website, smartphone, call, email, etc. For example, eprimo, a subsidiary of the German utility Innogy, does 70% of its business online [13]. It reduces costs for utilities (cost to acquire and cost to serve [14]), while making the customer more active in his energy consumption. Furthermore, digital enables smart home solutions (such as Greenely [15], in Sweden, or Centrica's Hive Active Heating in the UK), which enable customers to better monitor and control their consumption, while increasing positive customer contacts with the utility. Digital also offers quick and simple tools for a residential consumer to evaluate their home's solar power potential (ex: Google Sunroof).

*(11) i.e. that cannot be turned on or off to meet the economies' fluctuating electricity needs.*

*(12) See also PELLERIN-CARLIN T. and SERKINE P.,* From distraction to action. For a bold European Energy Union innovation strategy, *2016.*

*(13) See innogy website: https://iam.innogy.com/en/about-innogy/webstories/digitalisation-of-the-energy-sector*

*(14) Capgemini Consulting analysis: best performers regarding cost-to-serve all use digital channel in more than 50% of their customer contacts.*

*(15) Energy consumption monitoring solution. Greenely's CEO, Tanmoy Bari, was nominated in Forbes "30 under 30 Europe" in 2016.*

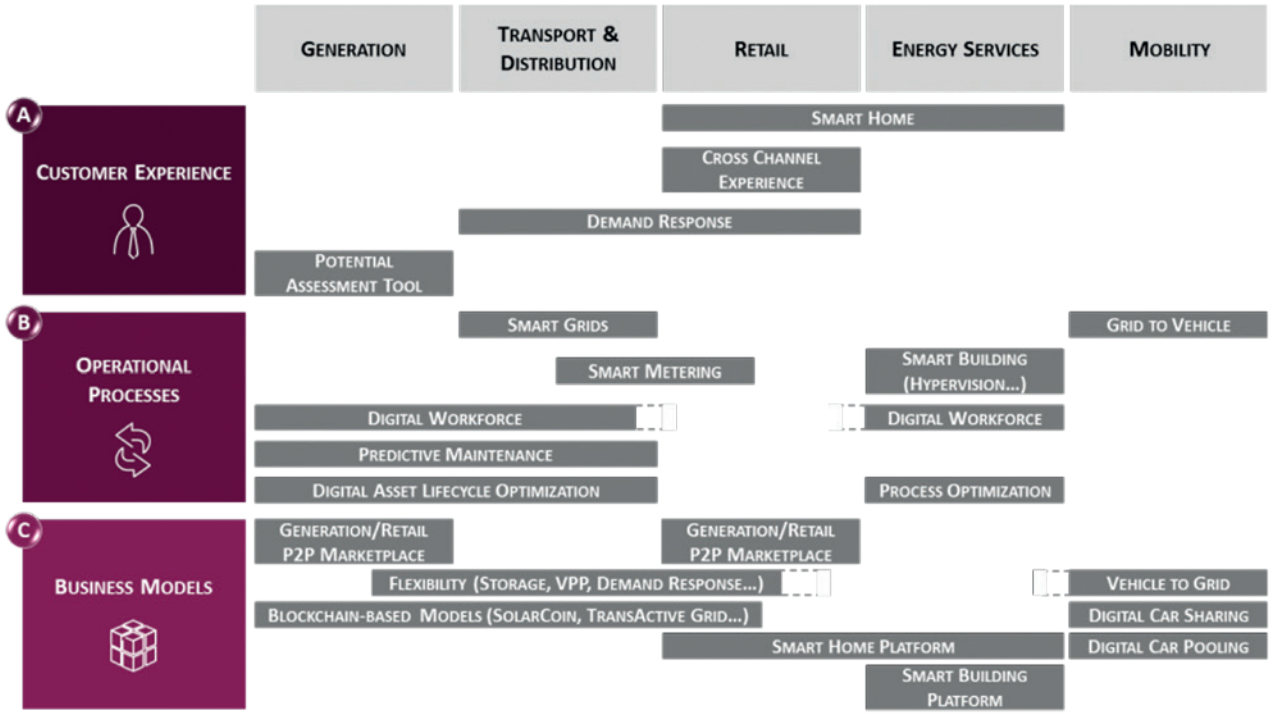


Figure 2: illustrations of Digital levers for the energy transition (not exhaustive).
Source: Capgemini Consulting.

"Digitalization is the catalyst for improved situational awareness. It helps customers reach their energy objectives – enhancing energy efficiency, sustainability, resiliency, and security – in alignment with their business objectives*."

**Emmanuel Lagarrigue, Chief Strategy Officer, Schneider Electric**

*(*) To do so, Schneider Electric's IoT platform, EcoStruxure, provides buildings, industry processes, datacenters and the grid with a way to achieve their digital transformation.*

## Digital operations improve the integration, performance, integrity and security of energy assets and workforce

Given that the energy sector is particularly asset-intensive, applying digital levers to the operation of these assets is especially valuable at all stages of the energy value chain, from power generation to consumption. For networks and decentralized infrastructures (transport, distribution), digital technologies, like advanced data analytics, can be applied to real-time process controls or losses management, remote field interventions or predictive maintenance. For decentralized energy equipment (RES, energy services), technical centers can be used to support interventions on the field, enhance energy efficiency and service quality.

Applying digital to operations, meanwhile, enables innovative responses to energy-related companies' challenges. The benefits include: integrating more renewables into the system, increasing safety levels, optimizing costs, maximizing profitability and enhancing the quality of service (QoS) or the reliability of the assets. A variety of technology levers are available:

- **Digital cockpit**, process control automation/optimization (IoT, big data & analytics, radio-frequency identification (RFID), machine to machine (M2M)) can help monitor, optimize and simulate real-time power flows on a system, such as the artificial intelligence solution of the company DCbrain;
- **Smart interfaces for digital workforces** (mobile solutions for planning and dispatching, route optimization, remote support to field intervention, augmented and virtual reality, robotics and drones) can improve operator interaction with on-site assets or equipment, improve spare part sizing and availability, enhance intervention quality first time, optimize workload management, and perform dangerous tasks more safely and quickly;
- **Online collaboration platforms** and tools (remote, extended enterprise) can offer different ways of working within the company and with external partners, and facilitate collaboration in multi-site environments;
- **Asset optimization** (IoT, big data & analytics, simulation/modelling, cloud, artificial intelligence) helps anticipate failure, predict behaviour, and optimize maintenance and investment plans.

Over the last 2 years, most energy-related companies (covering generation, T&D, services, etc.) have begun to acknowledge the benefits of these digital operations levers. Many actors are now moving fast and making significant investments. For example, French transmission system operator (TSO) RTE[16] has made digital a strategic

axis and dedicated part of its Capex to digital. RTE aims to invest 10-20% of its annual network investment in digital solutions, with the goal of building the first European smart electricity network.

## New digital business models create value focused on data, decentralized opportunities, and flexibility

Digitalization is fostering the transition of the energy sector from a product-centric to a solution-oriented approach combining connected products and services in a way that is more conducive to decarbonization. As part of this, digitalization is enabling a wide spectrum of new business models. In particular, three types of activities are emerging.

***Data collection and analysis are key aspects of value creation***

One of the key challenges for energy companies is to maintain their customers' loyalty. Gaining more consumer insights is an important part of the new data-centric value chain. For instance, Eneco, with its "Toon" smart home platform (Smart thermostat, Solar PV management, EV charging and household equipment management) installed in more than 400 000 households, now collects exponentially increasing volumes of data. It has leveraged Toon to pivot its business model, becoming a data-centric smart services company. Eneco positions itself as an orchestrator of the Smart Home platform while opening its Open Application Programming Interface (API) to other stakeholders providing non-related energy services to end users (such as security, fire detection, transports or weather information).

GE has also developed a data-centric model with its Predix solution, a cloud-based platform that collects data from industrial utilities (Turbines, Boilers, Water treatment plants…) or process equipment (Distillation tower, Hoven, Assembly lines…) and enables large-scale analytics for asset performance management.

***Digital transformation and technological enablers boost the creation of local energy business models***

New entrants to the energy supply market and peer-to-peer marketplace are at the forefront of the decentralization movement. The first category includes new independent energy suppliers, local authority-owned utilities and community-owned utilities. Their solutions use digital assets either to optimize costs or to better manage power flows. For example, TexelEnergie in the Netherlands, is gradually transforming Texel Island (13,600 inhabitants) in a self-sufficient energy community with locally generated renewable energy and microgrids.

The second category consists of platforms that bypass traditional retail utilities by connecting energy producers and consumers. Notable examples from different countries are SonnenCommunity, Vandebron or TransActive Grid.

SonnenCommunity is a virtual power plant that connects a German-wide community of distributed generators and energy storage users.

Vandebron, a Dutch startup, offers a peer-to-peer platform that enables consumers to buy electricity directly from independent producers.

TransActive Grid is a New York peer-to-peer platform without any central coordination enabled by the blockchain technology [17].

> "End users are now expecting digital integrated turn-key energy solutions. Acknowledging these growing needs, we have proposed a new data management platform and web services mixing energy supply, consumption monitoring or advanced invoicing services. Doing so, Primagaz has completely reconsidered its business model* working internally in parallel on a revised target operating model to supply gas."
>
> **Yves Michel, Primagaz CIO and Caloon CEO**
>
> *(*) with its Caloon offer.*

***Flexibility (in particular demand response and energy storage) offers new perspectives for grid balancing***

The European demand response market is attracting tech start-ups, which see its high growth potential due to growing peak electricity demand and narrowing capacity margins. In 2015, Tempus Energy (UK) started encouraging customers to move their energy usage away from peak demand periods to times when cheap renewable generation is available [18]. To do so, digital technology is needed to collect and analyze the data and to inform customers in real-time.

> "Digital will ultimately transform Grid architectures requiring to deploy, with the support of European institutions and public authorities at a country level, new flexibility market platforms, which will enable transactions Horizontally (across Countries and Regions) as well as Vertically (from Prosumer and Microgrids into Grid balancing mechanisms). ENTSO-E and Grid Operators are preparing to facilitate the emergence of such new "App Stores" across the energy value chain."
>
> **Laurent Schmitt, Secretary General, ENTSO-E**

New energy storage developments, enabled by digital tools, introduce unprecedented opportunities for producers, customers, potential third-party operators, and even DSOs. For example, Orange's thousands of batteries (located at 7000 telecom facilities), combined with Actility's digital technologies, in partnership with French TSO and DSO, have enabled to provide and activate a flexibility capability in response to spikes in energy demand. The intelligence of the IoT allows coordinating the power storage of 7000 sites in minutes, providing flexibility to the system operator.

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*(16) Enerpresse n° 11612, 2016.*
*(17) A blockchain is a distributed digital database that maintains a continuously growing list of ordered records called blocks. Each block contains a timestamp and a link to a previous block. In the case of Transactive Grid, the blockchain supports the transactions of power and money (or here a crypto-currency called token).*
*(18) Verdantix, "Innovation and Disruption in the Global Utility Ecosystem", 2016.*

## Operating models of energy and non-energy actors are changing to take advantage of opportunities

### Internally, companies' operating models are changing rapidly

Major companies are adapting their organizational structures and creating new business units dedicated to the energy transition. They are also empowering themselves with dedicated digital-related capabilities and skills. Focusing on organizational structures, there are numerous European and global examples, such as Total and Shell… Radical steps have also been taken by E.ON and RWE in Germany. Both energy giants have separated their fossil fuel assets from their energy transition activities: renewable assets, smart energy networks, and downstream activities in charge of digital energy services.

Companies are also recognizing a need to build new capabilities (such as IoT and machine -to -machine expertise, data science or cybersecurity) and creating new C-level positions within their organizations to do so. In 2015, Chief Digital Officer positions were created in many companies such as in Enedis, Enel Green Power, Enel, GE, Total (which also created a new role of Chief Data Officer) or Engie. Gartner estimates that 90% of large organizations will have a Chief Data Officer by 2019 [19].

"The energy sector is facing considerable changes at a fast pace. Consumers are now expecting comprehensive low carbon solutions integrating digital energy efficiency services. To meet customer expectations, Total has drawn a new ambition with, notably, the creation of its GRP division dedicated to Gas, Renewable, Low Carbon Solutions and Smart Energy services".

**Jérôme Schmitt, Senior VP Innovation & Energy Efficiency, Total Gas, Renewables & Power.**

### External collaboration models are also changing with enlarged innovation ecosystems

To develop new, digital-related, products or solutions, many companies have launched new initiatives that bring together a wide range of actors such as start-ups, engineering companies, equipment providers, research institutes or Telco and new technology firms.

Numerous companies (such as ENGIE with its OpenInnov, EDF with Pulse, Enel, Endesa, Iberdrola) have implemented start-up incubators or programs to stimulate innovation. Enel's Spanish subsidiary Endesa launched an open innovation platform, Endesa Energy Challenges, in October 2015. Its initiatives included a Datathon (that challenged the global community of big data experts to transform the future of energy in Spain) and a Hackathon (that challenged young talents from various fields to design innovative mobile solutions to help customers optimize energy consumption). Similarly, the Iberdrola Energy Challenge was launched in 2016, with the support of KIC InnoEnergy, to create new responses to Europe's energy situation.

Likewise, many innovative energy solutions are being driven or tested at city or district level. These include energy efficiency initiatives, electricity, heating and cooling supply systems, and the integration of renewables in the built environment [20]. Local and regional public authorities have been key initiators or enablers of wider innovation energy ecosystems, which are central to smart city initiatives that combine energy, transport and urban planning. For example, the city of Barcelona, involving citizens, public and private companies, is thought to be on its way to energy autonomy, powered by advanced analytics and energy management solutions. Vienna is positioning itself as a leader in the electric vehicle space with more than 400 charging stations. The North Sea Region academic network has developed a customization process that monitors and evaluates the consumption of energy and carbon emissions in proposals for building retrofit.

Facilitators such as the EU's Knowledge and Innovation Community (KIC) InnoEnergy [21] as well as NUMA, are also playing central roles in supporting startups by connecting them to large corporates and cities and build synergies for activities related to energy, transport and smart cities. Their aim is notably to combine the speed and innovative capacity of start-ups with the critical mass of big organizations, be they public (e.g. cities) or private (e.g. corporates).

Finally, financial institutions such as the EIB and CDC, in France, are also supporting the energy transition – be it through match-making, incubating, or pooling projects. The CDC, and the EIB through its targeted technical assistance programs such as the ELENA (European Local Energy Assistance) facility or the European Investment Advisory Hub have begun to support cities and regions in securing investment for projects that deploy energy-related innovations and the aggregation of small, dispersed low carbon projects. Private banking institutions are also playing in this space, such as BNP-Paribas with its Sustainable Finance initiatives and dedicated business unit.

"Digitalization is clearly a key enabler to accelerate the transition to a low carbon economy. Major financial institutions have launched large programs to boost financing of renewable energy projects and beyond. As part of our commitments towards digitalization and the energy transition, we have decided to invest 100 million Euros in clean startups dedicated to energy storage and smart grid".

**Virginie Pelletier, Head of Sustainable Finance & Investment at BNP Paribas CIB.**

*(19) http://www.gartner.com/newsroom/id/3190117. All these positions are supported by data scientists, who ensure data security and create mathematical models translating operational issues into actionable solutions.*

*(20) Capgemini, European Energy Markets Observatory, 18th Edition, 2016.*

*(21) KIC InnoEnergy supports entrepreneurs and startups building sustainable businesses that expand and enhance Europe's ecosystem (133 supported as of May 2016).It connects innovators and business partners by investing in commercially viable products and services (71 launched as of May 2016) and runs Master's, PhD and further educational programs at European universities.*

## To reap the benefits of this fast growing business, more needs to be done

Digitalization is pushing companies in the energy sector to innovate and adapt. Yet to foster and accelerate the energy transition, energy-related companies now need to fully embrace the opportunities offered by digital ranging from best-of-breed customer experience to operations excellence and to disruptive business models, some examples of which are discussed above.

Europe has clear strengths in this area. However, it has not yet fully exploited the potential of digital technologies for revolutionizing all aspects of the energy-innovation value chain. At the European level, the measures envisaged under the Digital Single Market Strategy will need to be better linked with Europe's Energy Union. Full mastery of digital technologies and their various applications – which includes addressing concerns over data security, privacy, ownership and access – is a prerequisite for remaining at the forefront of the shift to the mixed products/services model that will set off the next wave of innovation in the energy sector.

A blend of promotional, incentivising and regulatory policies will also be needed to ensure the maximum private and public good from the "digital hand". Governments will need to provide a sound regulatory environment for dealing with quickly evolving technologies and business models, and it will be important that there be a close and continuous dialogue between policy makers and energy actors to ensure that unnecessary barriers are avoided. Particularly important on the regulatory side will be the new competition policy concerns that digitalization brings, as well as ensuring the right level of standardization to ensure interoperability between countries. Governments will also have a key role to play in building the right skills to set off the next wave of energy intelligent startups as well as additional digital infrastructure.

Finally, for Europe to benefit from this mega-trend at home, as well as exporting its know-how internationally, a wide range of multi-stakeholder and multi-sector collaborations will be essential. Beyond national governments, cities must continue to drive digitalization at a faster pace. Companies and industries increasingly understand that the complexity of today's world means that no single company can come up with a complete solution. A wide variety of actors from a diverse group of different business sectors, civil society as well as cities and households need to cooperate and will be central to a successful transition.