Landis+Gyr
manage energy better

pathway 07

digitization

building an intelligent grid blueprint

from the editor

The Internet of Things, Industry 4.0, Smart Factoring, Intelligent Networks – the future has many names and at least as many facets, but only one root. Digitalization will revolutionize the energy sector, change established business models, and create new ones. To be more precise: it is already happening. Digital data and information have long been playing a key role in all areas of life and energy supply cannot and will not be an exception.

Digitalization is a huge step that can be taken only in close alliance with all involved – regulators and politicians, infrastructure operators and suppliers, solution providers and end customers. But not even digitalization will be able to override the laws of the market or of economics.

What does my customer want? How can I generate added value and design my processes to be more efficient? What solutions and services can I use to create a sustainable business model and increase customer loyalty? There are so many important questions that go well beyond technology. Precisely for this reason, it is important that the unavoidable investments in digitalization are future-viable and that hardware and software remain current and upgradable in the long term. In order to achieve this objective, Landis+Gyr cooperates closely with its customers, associations and other market players. Only by these means can we successfully realize compatible and interoperable solutions for network automation and the digital transformation of energy production, storage and supply.

We present some examples in this issue, as well as the viewpoints and estimations of key protagonists in the sector. Digital topics in pathway – a medium that not only appears digitally, but also in an analog print version? To us that is no contradiction, but rather symbolizes a transformation process that will continue for many years to come.

We hope you enjoy reading pathway!

Oliver Iltisberger
Executive Vice President EMEA, Landis+Gyr

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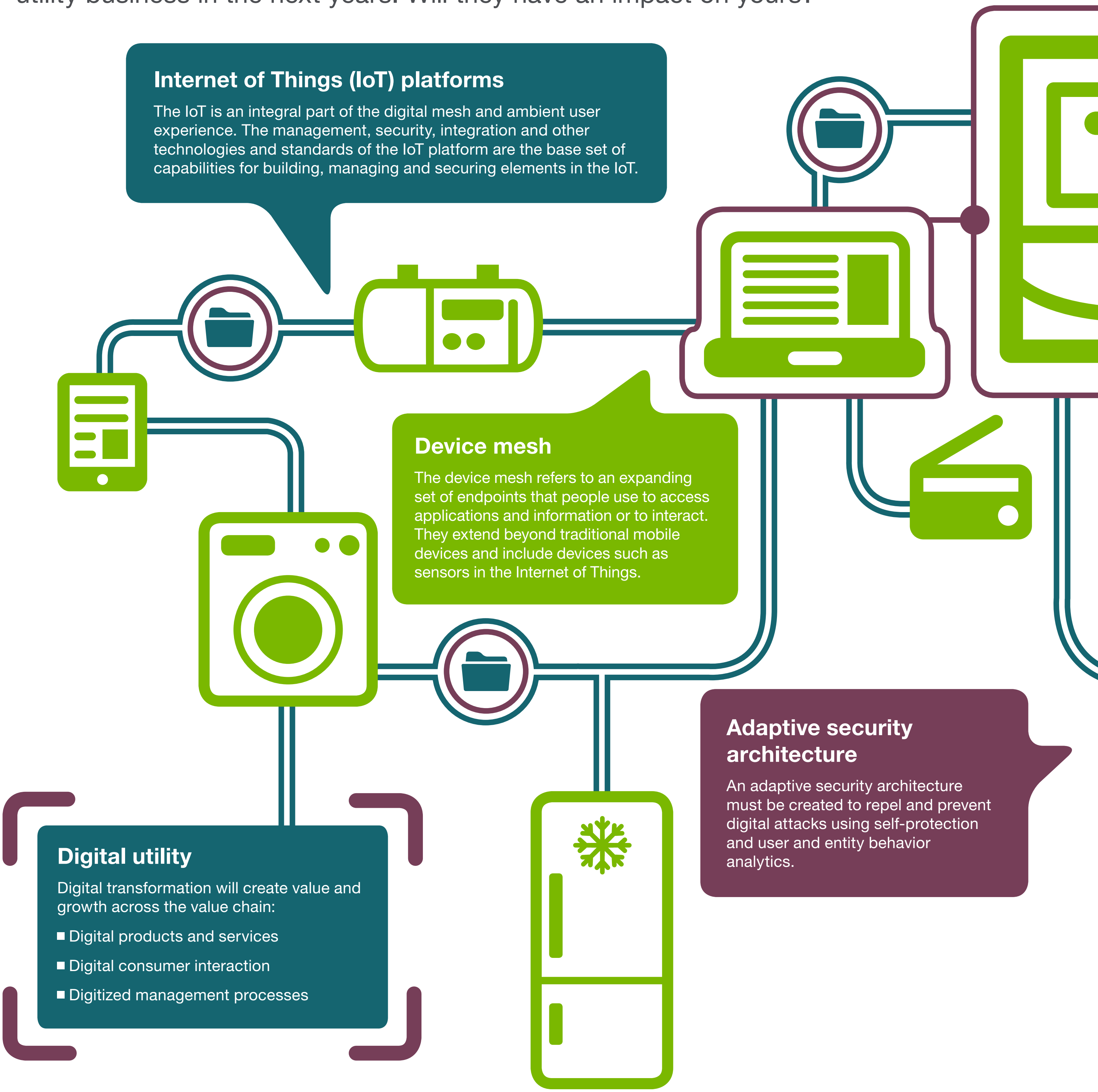
digital transformation

According to Gartner and Accenture research, these technology trends will shape the utility business in the next years. Will they have an impact on yours?



Internet of Things (IoT) platforms

The IoT is an integral part of the digital mesh and ambient user experience. The management, security, integration and other technologies and standards of the IoT platform are the base set of capabilities for building, managing and securing elements in the IoT.

Device mesh

The device mesh refers to an expanding set of endpoints that people use to access applications and information or to interact. They extend beyond traditional mobile devices and include devices such as sensors in the Internet of Things.

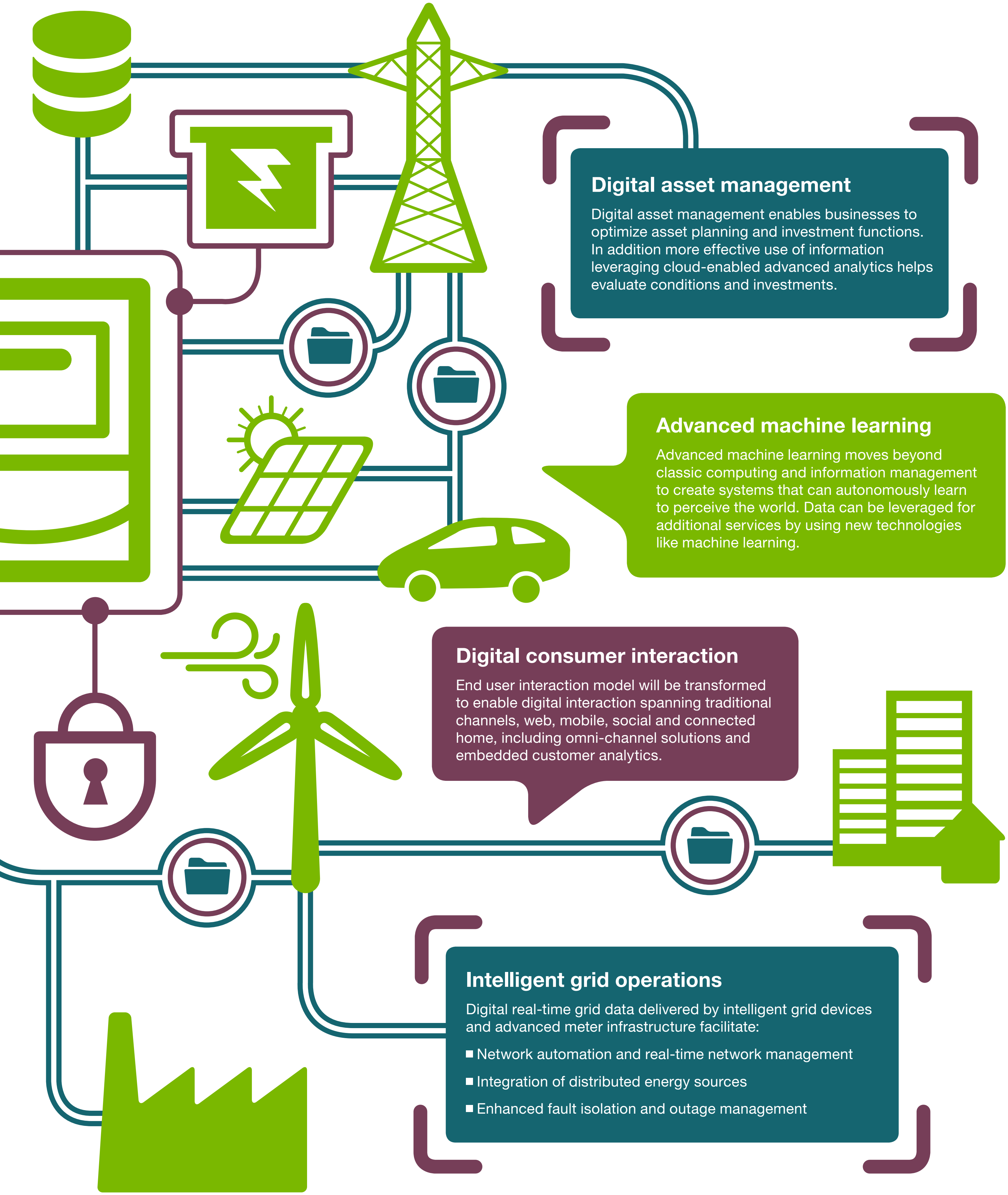
Adaptive security architecture

An adaptive security architecture must be created to repel and prevent digital attacks using self-protection and user and entity behavior analytics.

Digital utility

Digital transformation will create value and growth across the value chain:

- Digital products and services
- Digital consumer interaction
- Digitized management processes



Sources: www.gartner.com/newsroom/id/3143521 www.accenture.com/us-en/insight-digital-utility-infographic

the digital grid:

a golden opportunity for utilities to reinvent themselves

Grid digitization offers utilities the chance to redefine their business models by improving their internal operations and the services they deliver to end consumers.

It is important to distinguish between “digitalization” and “digitization.” These terms are not interchangeable. The former refers to the impact of information and communication technology (ICT) on society at large and, in particular, how it transforms the interactions between people and between people and objects. Grid digitization, by contrast, refers to creating visibility on the grid by using sensors to collect analogue data, which is then transformed into useful digital information that adds value to businesses and users. When implemented, grid digitization makes utilities much more active participants in the energy market. Rather than simply distributing energy to end consumers, distribution system operators (DSOs) now have the opportunity to work as part of a larger ecosystem that benefits all market stakeholders. Advantages of the new digital grid model include greater reliability, increased financial transparency, supply-demand and product-service integration. The potential combined result of these advances is a fully automated, resilient, ‘self-healing’ energy network.

“It starts with using digitization to create visibility at all levels of the power grid,” says Thierry Pollet, Head of Product Management Smart Grid at Landis+Gyr. “Utilities already have this capability at higher voltage levels, but implementing it at lower voltage levels will make all the difference.” Grid digitization at lower levels enables the capture of key voltage and current parameters and, from these, active and reactive power parameters can be derived in addition to power quality and non-electrical parameters like temperature, humidity, and vibration. Utilities can then leverage all data inputs with advanced techniques such as machine learning and analytics. This opens up considerable opportunities for new and better services to end consumers.

Key challenges and drivers for smart grid digitization

Energy infrastructure: Renewables

The enduring challenge of renewable energy sources is that they are intermittent. Smart grids make it possible to effectively manage these inputs - both from large commercial operations as well as from end users themselves. The changing consumer role in the energy market means there will be ever-increasing numbers of small- and medium-sized distributed energy resources going online. These include photovoltaic, wind, combined heat and power and direct or indirect storage. Critically, the smart grid makes it possible to balance and manage what could potentially be millions of inputs of vastly varying sizes. It is achieved by accurately predicting supply and demand and then managing it by incentivizing end users to optimize usage patterns – and it does so with the aid of storage solutions.

Energy infrastructure: Storage

Effective energy storage technology significantly enhances the efficiency of smart grids. Battery storage makes it possible to control fluctuations in frequency of the power system, to automate voltage regulation, optimize demand and supply, and provide reliable back-up in blackout or disaster situations. To put it simply, energy stored in batteries during low demand cycles can be released during high demand periods. The volatility of renewable energy sources makes it necessary to compensate for frequency fluctuations and resulting network instability that can lead to operational disturbances in equipment connected to it if not properly managed. Little wonder battery energy storage solutions are gaining momentum with major utilities around the world (see page 10).

ICT: Super-connectivity means better services

Improving customer service is a core issue for utilities. The huge amounts of data generated by the millions of devices connected to smart grid enables them to respond to emergencies or faults more quickly and even predict and remedy failure before it impacts end users. The net result of this ‘self-healing’ system is reduced downtime and increased customer satisfaction.

ICT: Creating efficiency through convergence

ICT also makes a greater degree of IT/OT convergence possible. IT/OT convergence refers to the integration of information technology (IT) systems with operational technology (OT) systems that monitor events, processes and devices and make adjustments in enterprise and grid control systems such as supervisory control data acquisition (SCADA). Again, the increased speed at which data can be converted into intelligent and actionable information improves the ability to better respond and adapt to customer needs. This responsiveness is enhanced still further by the fact that convergence leads to more effective asset management. Business leaders can make better investment decisions in respect of maintenance, replacement and expansion of grid assets, so both consumers and service providers gain increased value.

White paper “How smart grids lead to IT/OT convergence”:

www.landisgyr.eu/resource/white-paper/

"Investment in digitization has to be balanced against the extent to which it increases efficiencies and reduces costs for utilities as well as enhances value and service levels for end users."

Thierry Pollet, Head of Product Management Smart Grid, Landis+Gyr

ICT: Cyber-security

While ICT enables smart grids it also opens the door to potential security risks, as is illustrated by partial shutdown of the Ukrainian national grid during December 2015. Privacy for end users in relation to how their electricity usage data is managed and shared is also a perennial concern. The deployment of IP-based communication networks across grids means data can be accessed by anyone from anywhere unless appropriate security mechanisms are put in place. The network and the millions of devices attached to it need to be secured as far as resources and practical realities of grid operation allow. While no solution is ever 100% secure, it is possible to achieve highly effective levels of smart grid security as is discussed in greater detail on page 18.

ICT: Internet of Things

The Internet of Things (IoT) will improve the customer experience and enable the creation of new utility services capable of adding value to both the end user and the energy company. This is made possible by real-time data collection and analytics enabled by industrial Internet protocols such as iPv6 that facilitate simultaneous collaboration between any number of companies as well as the integration of multiple services. For example, smart meters can communicate with a host of other objects and applications connected through the ICT network. This can be used to feed supply and demand information into the energy market and keep end users up-to-date on the latest buy and sell prices for energy.

Regulatory environment

The EU's new environmental targets[1] stipulated in the 2030 framework for climate and energy are built around increasing the percentage of renewables connected to the grid, reduction in greenhouse gas emissions and energy efficiency. Digitization is a vital enabler because it allows renewables to be seamlessly integrated into the grid. Furthermore, it makes the grid more efficient, which automatically prevents unnecessary production of CO_2. For example, when it comes to key energy consumption areas like heating and mobility, a digital grid can route electricity where it is needed when it is needed without undue wastage.

Another reason why it's important for utility companies to consider digitization is the impact of directives and legislation on renewables, for example, the new German regulations for grid digitization[2] discussed in the Netze BW article in this magazine (see page 24) and the EU Renewables directive[3]. These make it necessary for utilities to adapt grids to cope with increasing amounts of renewable energy sources, be they wind, solar or hydro. The intermittent nature of these sources means network operators need to be able to accurately measure, manage and react to changes as they occur.

There is further EU legislation related to efficiency[4]. The fact that grid digitization makes network activity visible allows grid operators measure where technical losses (energy lost in the operation of the grid) occur and take the necessary measures to combat them. Utilities are also subject to local, regional and national regulation, for example, with regard to minimum delivery standards and network quality. Digitization gives energy providers the necessary reporting mechanisms to ensure simple and cost-effective compliance with regulations.

In addition to promoting energy efficiency and improved performance, the data that smart grids produce can be used to:

- forecast energy demand
- educate consumers in an effort to affect their usage patterns
- improve existing services to consumers
- offer new services
- build customer loyalty by preventing power outages
- reduce the need to build new power plants.

This data raises questions as to who owns it and who should be entitled to leverage it. In its report on "The Future Role of DSOs,"[5] the Council of European Energy Regulators (CEER) stated that: "… consumers have the legal right to control their own data. However, DSOs, who in most cases have data directly from smart meters, have a special responsibility to act impartially and to make available necessary data to other parties, while respecting data protection legislation and the fact that consumers own their own data." CEER suggested that there is a need for a neutral data coordinator or data hub to manage and provide access to data. Hence, a set of guiding principles has to be developed for the relevant national authorities to oversee or determine the extent to which DSOs can manage data.

Costs and benefits

A critical consideration for utilities moving towards digitization lies in deciding where, and to what level of granularity, they want to digitize. Investment in digitization has to be balanced against the extent to which it increases efficiencies and reduces costs for utilities as well as enhances value and service levels for end users. "Ideally, you would have a full digital representation of the entire grid at all times. However, this means you would have to install costly sensors at many points, which can be prohibitively expensive," says Thierry Pollet. A further issue utilities must consider is connectivity. Data generated by sensors and smart devices have to flow over a communication

1 European Commission Energy Strategy 2030 https://ec.europa.eu/energy/en/topics/energy-strategy/2030-energy-strategy
2 www.germanenergyblog.de/?p=20000 3 European Commission Renewable Energy Directive https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive
4 EU Energy Efficiency targets https://ec.europa.eu/energy/en/topics/energy-efficiency
5 CEER Conclusions Paper on The Future Role of DSOs 2015, July 13, 2015 www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Cross-Sectoral/Tab1/C15-DSO-16-03_DSO%20Conclusions_13%20July%202015.pdf

network, which also comes at a cost. Hence, the level of investment required must be decided on a case-by-case basis to ensure the best possible cost/benefit ratio.

The full potential of the digital grid is comprehensively explored in the 2016 GRID4EU Report on "Large-Scale Demonstration of Advanced Smart Grid Solutions with wide Replication and Scalability Potential for EUROPE."[6] The project involved such DSOs as Vattenfall (Sweden), RWE (Germany), Iberdrola (Spain), Enel (Italy), and Enedis (formerly ERDF) from France. The GRID4EU projects were tested over a period of 51 months and included the monitoring of an LV network based on AMI infrastructure and intelligent equipment in secondary substations (Vattenfall); implementation of advanced control systems to increase hosting capacity and maximize the integration of distributed renewable energy sources in the MV network (Enel), to name a few.

In brief, the results of the GRID4EU study show that voltage and load control are beneficial in increasing network hosting capacity in distribution grids; the interaction of distributed generation and demand is a key to increasing network hosting capacity; and fault localization and restoration time can be reduced with greater automation at MV and LV levels.

The fact that smart grid systems rely heavily on ICT makes it essential to promote and enable the "convergence" of electric distribution and communication infrastructures. The "human component" is of paramount importance in smart grids and the necessary skills, training and processes must be in place to enable them.[7]

The road ahead

Europe is currently defining its future energy model. As you read this, the European Commission is working on proposals for Energy Union, which will come to a conclusion in 2016 in the form of new legislation. One result will be a new electricity market design that determines the roles that DSOs, as regulated entities, can take up. "The role of distribution system operators will evolve from ensuring safe and reliable delivery of electricity to acting as market facilitators by empowering end users and engaging with the other market stakeholders," says Thierry Pollet. In addition, end users will become more active participants in the system. This has the potential to help keep energy affordable. For example, end users could offer improved flexibility by making their own power generation available for grid control, or by sharing electricity produced within the community. Regardless of the roles end users play, they will need full transparency on electricity market pricing for their participation to work efficiently. Digitization makes this possible. ■

Where grid digitization is already delivering

There are a number of countries in Europe where grid digitization is already well underway.

- In the past two years, Landis+Gyr has supplied over 36,000 smart grid systems to Poland. The smart grid terminals were installed in substations for low voltage network monitoring and help control both technical and non-technical energy losses.
- In Germany, according to new regulations (as of January 2016), all decentralized energy sources with an output of more than 100 MW are required to have functionality that allows the energy generated to be distributed to the network directly. Developed by Landis+Gyr in cooperation with EnBW 3,000 SyM²-compliant S750 grid modules are being installed by Netze BW in Germany as part of the solution for managing the electric feed of large and medium-sized (≥ 100 kW) solar, wind, and other renewable energy power plants.
- In the Netherlands, there is currently a strong focus on improved customer service and operational efficiency, including a reduction of the number of customer minutes lost (CML) in the event of an outage (SAIDI). Deployment of 1,450 Landis+Gyr's distribution automation systems in medium and low voltage networks to date enables DSOs to address this challenge.

6 GRID4EU Report 2016 www.grid4eu.eu/
7 GRID4EU Report 2016, pp11 to 16 and pp37 to 234

megawatt-scale energy storage

opens up a new range of possibilities

The changing market landscape is creating a growing demand for advanced storage systems, especially with regard to renewable energy inputs. Toshibas' Battery Energy Storage System (BESS) does a lot more than make it possible to control fluctuations in frequency of wind and solar inputs. It automates voltage regulation, optimizes demand and supply, and provides reliable back-up in blackout or disaster situations. Little wonder this 1.2 MW battery storage unit is rapidly gaining favor with major utilities.

The recent installation of BESS in Helsinki, Finland is a case in point. Helen, one of the leading energy retailers in the Nordics, has set up a pilot system to study and test optimal operating principles together with the local DSO, Helen Electricity Network, and Finland's national TSO, Fingrid. The Finnish operators were looking for proven technology with an attractive price/quality ratio suitable for a smart grid environment. The Toshiba battery system supplied by Landis+Gyr has a rapid charging/discharging capability and a long 10,000-cycle battery lifetime which makes it ideal for smart grid infrastructure. Once the pilot is complete, BESS will become a permanent fixture in Helen's renewable energy generation structure.

Mind the gap

Regardless of energy source, BESS makes it possible to better manage demand. This is because energy stored in the 13,440 Toshiba SCiB™ battery cell units and the 560 storage battery modules (SCIB™ Type3-23 Ah) during low demand cycles compensates for gaps between power set points and current generation during high load periods. The BESS is also equipped with two power conversion systems for storage batteries, a battery control and management system with HMI and a three-winding transformer for interconnected systems. The advanced control and management system ensures power is fed into the grid as needed within the desired range.

Whether loading or discharging, BESS takes into account aspects like the current temperature of battery modules, the state of charge (SOC), charge/discharge rate, the characteristics of the inverters and the status of the grid.

Effective frequency regulation

The volatility of the renewable energy sources necessitates the use of highly responsive tools to iron out frequency fluctuations and resulting network instability that could lead to operational disturbances in equipment connected to it. This makes primary frequency control one of the most important use cases of a battery energy storage system. BESS is able to counter frequency fluctuations because it can be charged or rapidly discharged in response to changes in grid frequency. When the need arises BESS is capable of providing full power within milliseconds, creating an effective intervention until alternative reserves can be ramped up. In Finland, utilities currently provide the disturbance reserve for the transmission system operator (TSO) Fingrid. The installation of BESS means a utility can extend the portfolio of its reserve power offerings and provide the TSO with a new, more flexible tool to improve grid stability.

Automated voltage regulation

In addition to frequency fluctuation, distributed renewable energy inputs can affect voltage, power factor, and reverse power flow. Existing voltage control systems, such as tap changers in distribution transformers, may no longer be sufficient where generation is connected to the feeder. Overvoltage situations also have a negative impact on the service life of electrical devices. This can cause higher technical losses and trigger feeder line/ transformer protection. In reverse proportion, undervoltage situations are potentially equally damaging. They can cause flicker, alter the operation of synchronous machines, or unintentionally trigger device protection. Installing BESS means distribution system operators (DSOs) can balance voltage fluctuation by absorbing or injecting power as the need arises. The ability of BESS to compensate enables the DSO to keep the power factor within given limits and minimize network losses. In Finland, this means DSOs can avoid penalty fees imposed by the TSO for exceeding approved deviation levels.

Optimized demand and supply

BESS can also be valuably employed to smooth peaks and lows in electricity demand. Its batteries can be discharged during peak load and the reverse applies when demand is low, when its batteries can be charged. In Helsinki, BESS is used to optimize the purchase and sale of electricity, or to “buy low and sell high.” During peak load, the energy stored in batteries can be sold at top prices and there is also no need to buy additional power on the energy market. When prices are low, renewable inputs can be stored until such time as prices rise again. Helen will be investigating further business potential and business models for energy storage utilization during the course of its pilot project.

Backup for blackouts

In cases of blackout or major failure, vital infrastructure has to be kept going. Telecommunications, data centers, and hospitals are obvious examples of services that could be severely compromised through loss

Helen case study:
BESS installation in Finland:

www.landisgyr.eu/ resource/case-studies/

of power. BESS is a highly effective solution in this scenario because the energy stored in its batteries is immediately available and can bridge the gap until alternative back-up reserves can be brought online.

The considerable benefits outlined above make it clear that an ever-increasing number of battery energy storage systems will be incorporated into smart grid solutions in coming years. Effective storage is key to optimizing use of renewables.

Other BESS projects in operation

Two large-scale BESS systems have been installed in two different substations belonging to the Tohoku Electric Power Co. in Japan as a counter-measure to deal with network stabilization issues (frequency variation) caused by the penetration of wind and photovoltaic generation. The first system is a 40 MW/20 MWh BESS in Nishi-Sendai Substation, in operation since February 2015. The second system is a 40 MW/40 MWh in Minami-Soma Substation, in operation since February 2016.

Two 1 MW/1 MWh BESS systems have been installed for Terna S.p.A. in Sardinia and Sicily, in order to increase grid stability with high RES penetration. Terna tested different technologies from a grid and module scale perspective and Toshiba's SCiB technology was proved to be the best performing in terms of round-trip efficiency and aging (higher number of charging/discharging cycles).

One 500 kW/776 kWh BESS system has been installed for Gas Natural Fenosa in the Alcalá Substation in Spain to evaluate the batteries' effectiveness in responding at times of peak demand, as well as their capacity to manage electricity supply in places with high temporary or seasonal electricity demand. This project will also evaluate the batteries' effectiveness in terms of managing network fluctuations caused by renewable energy sources.

New BESS projects given go ahead

Two more BESS projects recently received the green light. The first was the result of a contract signed to provide a BESS system for an Italian renewable independent power producer, Enel Green Power s.p.a. It is envisioned that the 4 MW/1 MWh storage unit will be used to smooth the intermittent flow of power on a wind farm.

The second project in Tucson, Arizona, is more than double the size: Landis+Gyr will partner with E.ON Climate and Renewables and Tucson Electric Power (TEP) to provide a 10 MW energy storage system to help balance load and regulate frequency on the TEP distribution system. ■

The global energy storage initiative is heading east

44 billion

$ 44 billion to be invested in storage between now and 2024, with $8.2 billion flowing into the market in the final year of the period.

16 GWh

Worldwide, annual installation rates will have risen from just under 2 gigawatt-hours this year to more than **16 gigawatt-hours** in 2024.

71%

The top five markets, which also includes the United States and the whole of Europe apart from Germany, Italy and the U.K., will make up **71 percent** of all storage installed.

163 GWh

By 2024, BNEF predicts annual demand for lithium-ion batteries for electric vehicles will hit **163 gigawatt-hours**, or more than 10 times the capacity needed for stationary storage.

China

1.8 GW

India

2.2 GW

The real energy storage heavyweights in 2024 are expected to be India and China, installing **2.2 gigawatts and 1.8 gigawatts** of capacity, respectively.

Li-ion

90%

Lithium-ion has been the preferred technology to date and was used in **90 percent** of utility-scale projects, based on power output, in 2015.

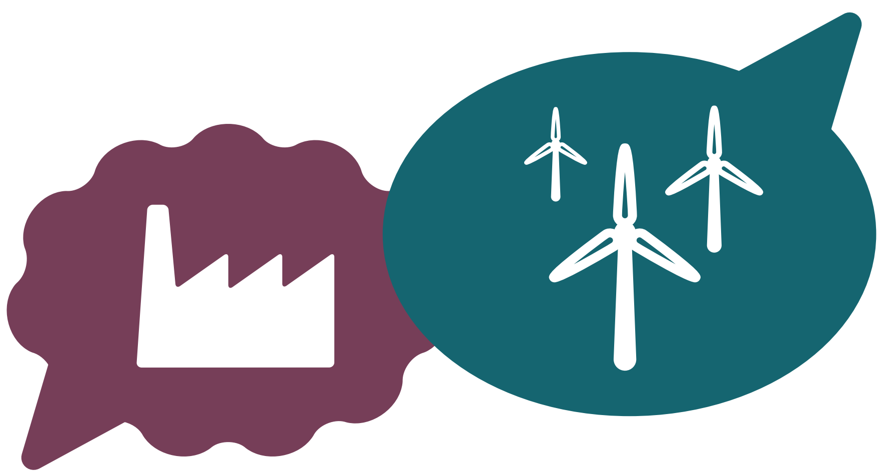
81.3 GWh

The Asia Pacific region will host a majority of the **45 gigawatts and 81.3 gigawatt-hours** of non pumped-hydro storage due to be installed worldwide by 2024.

Sources: Global Energy Storage Forecast, 2016-24, by Bloomberg New Energy Finance (BNEF) www.greentechmedia.com/articles/read/the-energy-storage-action-is-heading-east

the role of DSOs in the new energy market

In this round table, we look at what to expect from distribution system operators in the "new energy market." More specifically, we will discuss market redesign necessitated by rapidly proliferating renewables, changing energy policies, regulation, digitalization and their impact on the existing energy business and technological environment.[8] At the outset, we acknowledge that there are obvious differences among European countries in the number, size and activity profile of DSOs, as well as in the technical characteristics of distribution systems and the challenges facing each network operator.[9] This means that there is no hard and fast model for the role of the DSO and this conversation is intended to cover broad themes rather than the specifics of a particular market.



8 European Distribution System Operators for Smart Grids, Flexibility, 2014:
The role of DSOs in tomorrow's electricity market, 2014 www.edsoforsmartgrids.eu/wp-content/uploads/public/EDSO-views-on-Flexibility-FINAL-May-5th-2014.pdf

9 The Future Role of DSO's. A CEER Conclusions Paper, June 2015.
www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Cross-Sectoral/Tab1/C15-DSO-16-03_DSO%20Conclusions_13%20July%202015.pdf#

João Torres

João Torres is CEO of EDP Distribuição in Portugal. Under his leadership, EDPD has deployed innovative grid solutions that demonstrate the technological, societal and economic value of smart grid implementation. He has been serving as the Chairman of the European electricity distributors' association, EDSO for Smart Grids since 2013. The association is focused on guiding EU RD&D, policy and member state regulation to bring smart grids from vision to reality in Europe.

Participants in the discussion
João Torres, CEO of EDP Distribuição in Portugal and Chairman of EDSO, the European Distribution System Operators' Association for Smart Grids.

Garrett Blaney, Chairperson of the Irish Commission for Energy Regulation, and Co-chair of the CEER Working Group on Distribution Systems.

John Harris, Head of Regulatory and Governmental Affairs at Landis+Gyr for the EMEA (Europe, Middle East and Africa) region

pathway: *Let's open by discussing what you consider the most significant changes currently taking place at the distribution level – and how these changes are contributing to the development of the new energy market or system?*

John Harris: The whole energy supply framework – and the corresponding policy and regulation – is in a state of flux right now, and in the middle of all of this is the distribution network. Whether it is increasing the share of renewables in generation, enabling demand response or increasing consumer participation in the energy market, the role of the distribution system is key to the redesign of the power system and market.

João Torres: The world is now adding more renewable power capacity than new net capacity from all fossil fuels combined, and Europe wants to keep leading the way forward. This is just one of the major trends that is driving the changing DSO landscape.

Garrett Blaney: Two things are significantly driving change for distribution systems: Firstly, the wide scale deployment of distribution-connected renewable generators, and secondly the major changes in new technologies that impact on how energy is consumed. The challenge from a regulatory perspective is how to encourage distribution system operators, as neutral facilitators of the market, to embrace these changes to deliver positive consumer outcomes.

John Harris: All of these developments will significantly change the distribution system as we have known it in the past. As the majority of renewable capacity will be installed in the distribution grid, DSOs will have to make investments in intelligent technologies. The opportunities that these technologies open will then also be used to allow end consumers a more active role in the energy market. This, however, can only be achieved within a supportive policy and regulatory framework.

João Torres: Several other factors are worth mentioning as they too are shaping the future of the energy sector. Distributed energy resources (DER) and the different ways they can generate, manage and store energy on the consumer side are, by itself, a transformative force. Also extremely relevant is the digital evolution. Digital DSOs are moving towards a European digital single market (DSM), as well as exploiting synergies between the energy and the digital sector for the benefit of Europe's citizens and economy. Digitalization will be the key to structuring ever more valuable interaction with smart cities and consumers.

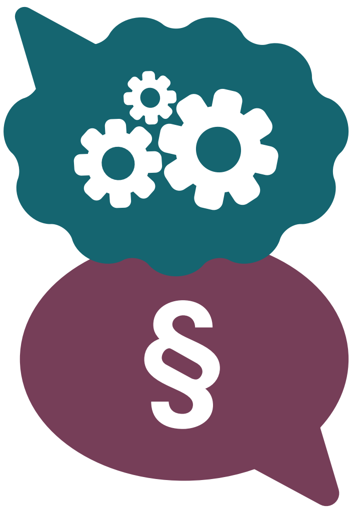
> "Digital DSOs are moving towards a European digital single market (DSM), as well as exploiting synergies between the energy and the digital sector for the benefit of Europe's citizens and economy." João Torres

pathway: *What challenges, opportunities and benefits does the new market offer DSOs?*

John Harris: The transformation of the energy supply system will present a number of challenges for the DSO, including how to keep the network stable in a world in which electricity flows are no longer mono-directional. In the past, electricity flowed from large power plants to end consumers. Now, we have a

John Harris

John Harris is Vice President and Head of Regulatory and Governmental Affairs for EMEA at Landis+Gyr. He acts as the communication interface between Landis+Gyr and legislators and other stakeholders across Europe regarding the environmental and energy policy debate as it relates to smart metering and smart grid – the subjects gaining increasing attention in the minds of policymakers and energy utility executives.



situation where electricity is being fed into the system at the end of the distribution network and flowing up. This is challenging.

João Torres: Depending on the dimension, location and availability of the emerging distributed energy resources, the power grid can be put under considerable stress, leading to poor quality of service and an increased risk of blackouts. The main players, including policy makers, regulators and consumers are not aware of this impact most of the time. Therefore, it's a huge opportunity to engage consumers in an effective way. DSOs are key players in helping to raise awareness amongst consumers through better communication and secure data management, while delivering electricity safely and enabling market innovation and development.

John Harris: As regulated monopolies, the DSOs are much more restricted than other market actors in how they can respond to these challenges. Much will depend on how the discussions on market design, the "new deal for energy consumers," a new renewables directive, etc. turn out in Brussels, and perhaps more importantly, how the new policy framework will be applied in the member states by the national regulatory authorities.

"DSOs will have to make investments in intelligent technologies. The opportunities that these technologies open will then also be used to allow end consumers a more active role in the energy market." John Harris

Garrett Blaney: There are about 2,400 DSOs across Europe and the size and scale of these organizations varies tremendously, so a "one size fits all" regulatory model is not appropriate. In the case of Ireland, for example, there is only one electricity DSO but in Germany there are over 800 of varying sizes. We develop best practice guidelines for European regulators to ensure that DSO changes align with positive consumer outcomes but how applicable these are varies on a case-by-case basis.

***pathway:** Could you discuss the role of DSOs in this new market? How does this affect the need for regulatory oversight, the relationship between DSO and TSO, the end consumers and other players? What economic and market conditions would prevail?*

João Torres: DSOs are regulated entities and need to keep evolving their own roles as system operators and neutral market enablers and facilitators, which include data handling and provision, and the ability to make use of flexibility services through new distribution constraint market platforms, as well as by performing local balance activities. These are meant to provide the means for consumers to benefit from this emerging reality while ensuring system resilience through a cost-effective approach.

John Harris: The future role of the DSO is one of the most heavily discussed topics in Brussels right now. Will they be given a very restricted role i.e., safe and reliable electricity delivery between generator and consumer while keeping the network stable? Or will the DSO be able to commercially capitalize on the opportunities that new technologies and dynamic markets offer? Looking at the literature, I think the Commission and the regulators are considering a more restricted role for the DSO and to leave as much as possible to actors in the competitive environment, whereas the DSOs would like to see their role as "neutral market facilitators" remain as broad as possible. We shall see.

Garrett Blaney: In CEER we see DSOs as a neutral market facilitator that takes a more active role in grid management, forecasting and cooperating with stakeholders. We are working on guidelines to encourage efficient TSO/DSO interaction to benefit consumers and the market in general.

John Harris: With more generation connected at the DSO level and more active users, the interaction between DSO and TSO will intensify. Information exchange is required for real-time control and supervision, flexibility management, balancing, capacity management and planning.

Garrett Blaney

Garrett Blaney is Chairperson of the Irish Commission for Energy Regulation (CER), and Co-chair of the Council of European Energy Regulators (CEER) Working Group on Distribution Systems. His lead responsibilities within the CER relate to electricity and gas wholesale markets, networks and interconnection, as well as European regulatory affairs. Blaney is also responsible for security of supply, renewable and conventional generation, research and development at CER.

João Torres: TSOs and DSOs remain responsible for the functioning of their respective grids and the legal tasks they are obliged to fulfill. Their cooperation, however, is already benefiting the future of energy in Europe. The recent publication of their common TSO/DSO data management report[10] for instance, provides input to the European Commission for an appropriate framework.

Garrett Blaney: The need for good regulatory oversight has arguably increased, and CEER is working on a paper offering guidance on how regulatory incentives can adapt to the changing market. A Europe-wide energy market driven from the third package has benefited consumers across the union and CEER is keen that DSO regulation supports market development and avoids unnecessary distortions.

pathway: *Could you discuss what key capabilities (business, operational, technical) the DSO needs to develop in order to take up its role in this new market space and, where relevant, what role your organization will play?*

John Harris: In its current role, the DSO maintains and develops the network to provide non-discriminatory access to generators and consumers to secure, reliable and efficient delivery of electricity between access points. The DSO manages a number of processes such as handling connection requests, switching, and customers moving in and out. This role could be expanded to pre-qualification, activation, control and accounting of resources that participate to flexibility services. In addition, DSOs may aspire to take a role in storage, e-mobility and data management.

João Torres: If DSOs are to be allowed to move forward with the right approaches regarding the technical and market integration of distributed resources, including electric mobility and storage (grid-scale and in-home solutions), then there will be fewer opportunities for adverse events to occur, thus ensuring a more successful transition. Innovation needs to be incentivized, particularly through smart regulation that enables system operators to instance, in new ICT tools, grid digitization and smart grid solutions.

John Harris: Landis+Gyr provides solutions for digitization of the electrical grid. This includes communication networks, grid sensors and smart grid applications. These provide the foundations for building up key capabilities of the digital utility. We also collaborate with DSOs in exploring new business models, for instance, services based on our battery energy storage systems.

> "There are about 2,400 DSOs across Europe and the size and scale of these organizations varies tremendously, so a "one size fits all" regulatory model is not appropriate."
>
> Garrett Blaney

Garrett Blaney: In terms of key capabilities, the DSOs might usefully look at the changes and innovations that have transformed the telecoms sector over the last decade. This might, for example, give them useful indicators and insights for the future in terms of rate of change and how best to manage it. CEER provides numerous approaches – including incentives, best practices and training – to support DSOs and customers in the transition to the new energy market.[11]

João Torres: EDSO for Smart Grids speaks on behalf of the electricity distribution business and is bringing smart grids from vision to reality. The association is the key interface between European DSOs and the EU institutions, promoting the development and large-scale testing of smart grid models and technologies in real-life situations, and new market designs. ■

10 www.edsoforsmartgrids.eu/tso-dso-management-report/

11 www.ceer.eu, generally, and specifically "The Future Role of DSO's. A CEER Conclusions Paper", June 2015. PP – 18 to 25 www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Cross-Sectoral/Tab1/C15-DSO-16-03_DSO%20Conclusions_13%20July%202015.pdf

brilliant technology needed to secure smart grids

The fact that information and communication technologies (ICT) enable smart grids is a double-edged sword. On the one hand, ICT makes it possible to significantly improve grid reliability, security, and efficiency by facilitating information exchange, managing distributed generation and storage sources, while also enabling active participation of the end consumer. On the other hand, attackers can exploit the vulnerabilities of communication systems for financial or political gain.

Illicit access via ICT potentially enables attackers to shut down power over large areas, or direct cyber-attacks against power generation facilities. Although attacks on grids are relatively rare today, they can and do happen – as illustrated by the Ukraine shutdown in December 2015. Attackers blacked out a portion of the country's grid by using stolen user credentials to remotely access and manipulate the SCADA industrial control systems. Over 220,000 customers lost access to power for six hours.

"The most popular attacks these days, including the hack of Ukraine's power grid, are performed with trojans. If a system is properly maintained, however, it should be possible to detect this virus in due time, thus preventing a complete shutdown. Cyber-security in smart grids is therefore becoming increasingly important," says Wim Ton, a Security Architect at Landis+Gyr.

The ongoing development of smart grids introduces new security risks because cyber-attacks can be potentially performed on a large number of intelligent devices connected to the network. Each device is a possible entry point into the network and considering that there are already about 2 billion IoT-connected smart grid devices – and this number is expected to reach 12 billion[13] by 2024 – the magnitude of the problem becomes apparent. Global smart meter deployment alone will cross the 800 million[14] mark by 2020.

Advanced Distribution Automation (ADA) systems and Advanced Metering Infrastructure (AMI) expose grids to potential abuses of data protection and privacy. Moreover, the fact that Internet Engineering Task Force (IETF) standards are increasingly used in smart grids also makes them more vulnerable to well-known network attacks such as spoofing, man-in-the-middle, denial-of-service, and others.

While few threats outweigh those presented by the prospect of cyber-crime, physical security remains a key consideration and is almost as difficult to address, again because of the vast number of components in the network, many of which are outside utilities. Physical destruction or interference with these devices presents obvious security risks.

Other potential risks that need to be managed include: implementing new IT systems that are incompatible with legacy grid infrastructure, human error, and ill-intentioned employees with legitimate access to systems.

A smart grid is a huge, complex network composed of millions of devices and entities connected to each other. Such a massive network comes with many security concerns and vulnerabilities.[12]

Security architecture and end devices

In order to mitigate the security risks, the smart grid solution is designed to ensure that the correct security protocols, practices and technologies are in place. Indeed, a fundamental component of information security is the use of encryption techniques to protect the communication among the smart grid devices and back-end systems.

In addition, the fundamental rule of grid design is based on the principle that the compromising of one device does not result in the compromising of any other devices: for example, good practice is the use of different access and encryption keys for different devices in order to avoid the theft of keys from one device compromising the whole grid.

Moreover, security requirements should be adapted for different devices. In residential meters, for instance, the focus is on privacy and protection of consumption

12 International Journal of Smart Grid and Clean Energy, vol. 1, no. 1, September 2012 13 enterprise-iot.org, 2014: http://enterprise-iot.org/book/enterprise-iot/part-i/energy/
14 Global Smart Grid Federation, August 2016: www.globalsmartgridfederation.org/2016/08/29/ensuring-security-and-reliability-in-smart-meters/

data. And in countries where it is possible to remotely disconnect users from the network, there are obvious concerns about operator errors or attacks that could cause mass outages.

Selecting encryption methods

"The encryption technology is dependent on the communication standards: for example, in DLMS (Device Language Message Specification) smart meter standards, encryption is used to encrypt and authenticate the payload of the messages. On wide-area networks, the TLS (Transport Layer Security) should be adopted since it is a common technology in use on the Internet."

For encryption, Landis+Gyr uses algorithms recommended by the NSA (US National Security Agency) and ENISA (European Network and Information Security Agency). Cross-industry experience has proven that developing algorithms in-house seldom leads to a secure product, and will cause problems when integrating components from different manufacturers into the same grid.

Effective key management

The security provided by encryption depends heavily on the encryption keys used because people with ill intent do not usually try to break the encryption algorithm, but rather steal the keys. No matter how good the algorithm, stealing the keys provides access to the information and control of devices. To minimize this risk, Landis+Gyr implements state-of-the-art key management techniques to ensure that encryption keys are securely generated and stored after the device has been manufactured and securely delivered to customers. This is based on a public key infrastructure system that facilitates all the key exchange processes – as already provided in modern online secure transactions in banking and e-commerce business.

Creating custom certificates

The combination of a public key and a name is used to create a certificate. Landis+Gyr operates its own public key infrastructure for its devices, and key pairs are inserted on the production line. This effectively puts a certificate into every product that says 'this is a Landis+Gyr device' as well as specifying the related serial number. This unique provision is especially attractive to customers who do not possess a public key infrastructure of their own since Landis+Gyr provides them, in effect, with an out-of-the-box security solution.

Information system security best practices

Another fundamental component of information security is the establishment of proper access control. Access to (and execution of) application service logic, fulfillment and assurance functions should be based on the role of the user (e.g., administrator, operator, auditor, etc.). This requires role-based access models to be supported. All users must produce credentials to prove their identity when accessing or launching tasks. Moreover, the user access management should be integrated with customer IT systems in order to facilitate both user administration and daily users' activities.

The smart grid system must log user actions and security relevant actions, events and alarms by means of an audit trail. This trail contains information, such as the date and time of an action or event as well as the users and systems involved. Examples of security relevant actions include a user logging in to the system and changes to credentials or to cryptographic keys.

Over the lifetime of a smart grid system, the software (firmware, applications, operating system, etc.) may also need to be securely replaced with newer versions. Landis+Gyr addresses these needs by providing technical controls, such as secure firmware updates and dedicated services to its customers.

Landis+Gyr's video on solution security:

www.landisgyr.eu/resource/videos/

Landis+Gyr's security solution:

- is standards-based
- relies on a proven, open architecture
- addresses every access point in the network

Integrated security approach

No matter what technologies are employed, it is impossible to create a 100% secure grid. Nevertheless, as a critical infrastructure, the smart grid requires the highest levels of security achievable within operational and financial constraints. Comprehensive architecture with built-in security from planning though to implementation and operation is essential. Only a holistic approach based on tested industry standards, trusted ICT and end devices – and partnership between technology vendors, DSOs and regulators in defining security policies and procedures – can keep smart grids secure. ■

Objectives of grid security

The aims of smart grid security can be summed up in three words: availability, integrity and confidentiality.

1. **Availability** requires timely access to information and distributed grid controls because disruption of this flow can cause degradation or power supply interruptions.

2. **Integrity** involves preventing unauthorized modification or destruction of information that may adversely affect decision-making and control in power management.

3. **Confidentiality** is about preserving authorized restrictions on information access and disclosure in order to protect personal privacy and proprietary information.

Iberdrola's smart meter rollout in Spain is nearing completion

For nearly a decade, one of the world's leading energy providers has been a major driving force behind smart metering and grid digitization throughout Spain: Iberdrola's STAR project is scheduled for completion in 2018 and will provide more than 10 million electricity customers with the advantages of smart technologies. Landis+Gyr has contributed to the project with expertise and the delivery of its reliable E450 PRIME meters.

Back in 2007, the Spanish government was one of the first European nations to legally mandate the introduction of AMM (automated meter management) for all of the country's energy providers, a step that would also entail the installation of smart meters for about 27 million customers. Iberdrola, one of the two biggest utilities in Spain, had long anticipated this development. "We were already focused on digitization at that time, so we viewed this legislation not as an obstacle, but rather as an opportunity for improving and growing our business," says Miguel Angel Sanchez Fornie, Director of Global Smart Grid at Iberdrola. "But first we faced the challenge of developing a standard for data communications that would support our Powerline Communications (PLC) approach for smart meters with flexibility, openness and maximum efficiency for establishing a smart network. Existing technologies at the time did not satisfy our requirements, nor did they seem future-proof."

Finding a "PRIME" solution for interoperability

Having standard telecommunication protocols is important for distribution system operators (DSOs) because most existing grids have evolved historically based on various technologies that make them very heterogeneous. Over time, technologies change and through corporate acquisitions and mergers DSOs are faced with complex challenges when it comes to consolidation through digitization. To overcome this hurdle, Iberdrola established the PRIME (PoweRline Intelligent Metering Evolution) Alliance to define open specifications as a foundation for Orthogonal Frequency-Division Multiplexing (OFDM)-based PLC communications. The group was initially comprised of just three utilities, but has since grown to include some 65 companies, with DSOs and manufacturers among them, including Landis+Gyr as a founding member.

Initial results were published in 2008, and today PRIME 1.4 is a flexible and robust protocol standard that supports security, speed and reliability in PLC multiservice data transmission. "Performance has exceeded initial expectations, and we have a high degree of interoperability that covers technologies from a large number of industry players," says Sanchez Fornie. "This is not only important for the Spanish market, but also for our international ventures."

Miguel Angel Sanchez Fornie, Director of Global Smart Grid at Iberdrola

Iberdrola customers with smart meters can track their energy data using a web-based app.

Stepping up the pace

With PRIME as the basis for establishing smart metering as mandated by Spanish law, Iberdrola launched the mass rollout known as STAR (the Spanish acronym for Remote Grid Management and Automation System) in 2010. The goal was the ultimate deployment of more than 10.5 million smart meters throughout Iberdrola's customer base in Spain. Initial work was focused on urban areas having a high consumer density, not to mention high demands in terms of security, reliability and service. Iberdrola has already equipped 76 percent of its consumers with smart meters, of which 1.5 million have been supplied by Landis+Gyr.

In addition, as a part of its grid digitization program Iberdrola has deployed smart grid technology, including remote management, monitoring and automation capacities, in over 45,000 transformer stations, which represents 50 percent of its substation assets.

As the smart meter rollout is now extending into rural areas, Iberdrola has anticipated a number of challenges – both economic and technological – that are typical of lower density regions. For example, to reduce complexity and keep costs under control, telecommunication gateways will be used to complement traditional data concentrator-based architectures. The integration of commercially available solutions as needed is possible thanks to Iberdrola’s open approach.

At the crossroads – current success and a promising future

In describing the PRIME standard and the STAR project at this interim point, Sanchez Fornie sees the success of both in the high level of interoperability achieved across all system layers and components: “The main challenge was to develop a high-performance global technology, both in terms of market coverage and applications, intended not only for metering but for the smart grid as a whole. At the same time, we were promoting specifications that would comply with existing standardization – such as ITU, IEEE, IEC, CENELEC – to allow for widespread and confident adoption of this technology by any utility worldwide.” Iberdrola has proven the scalability and performance of its digital solution by realizing its broad deployment of PLC-based smart meters across Spain. “Advanced security features applicable to different or all layers of the system, IPv6 and IPv4 support, plus forward error correction mechanisms that increase robustness in the extended band by up to 500 kHz, are key features that can eventually be adapted to different utility scenarios,” says Sanchez Fornie.

Proven benefits for both the DSO and consumers

Although project completion is scheduled for 2018, Iberdrola and its customers are already enjoying measurable benefits delivered by the smart metering solution – customer service has improved dramatically thanks to smart metering management, which has also reduced the need for engineering staff in the field. Service technicians can focus their attention on key tasks rather than having to perform routine jobs like connecting or disconnecting meters, not to mention repairing or adjusting devices on-site. Digitization enables precise monitoring that supports reliable and transparent service and delivery.

The E450 PRIME smart meters from Landis+Gyr feature advanced technology that delivers a high level of data transparency. In addition to tracking load and consumption levels, the meters provide for the measurement of energy that is generated – for example, from on-site renewable sources. Remote meter connectivity functions, consumption data, load profiles and defined thresholds can all be monitored to help customers manage their energy needs, costs and CO_2 footprint – Iberdrola even provides customers with a web-based app to do this. At the same time, Iberdrola is able to efficiently process the metering and grid information for billing purposes and for designing new business models in response to new and changing customer demands. The Landis+Gyr metering devices also report on various power quality events that offer insights into Iberdrola's low voltage network so that weaknesses are identified before any outages occur. Furthermore, the meters are secure and tamper-proof – attempts to open or manipulate the devices are automatically reported.

One innovative step leads to another

The targets achieved in Spain have encouraged Iberdrola to not only continue advanced development of its distribution grid, but also to investigate the possibilities of deploying digital metering technology in other markets. Pilots based on PRIME have already been conducted in company subsidiaries in Brazil, UK and USA; Low voltage remote control has been piloted by Scottish Power in the UK. As in its home market, Iberdrola is working on ways to boost reliability, efficiency, cost savings and environmental protection through its subsidiaries in other countries in order to optimize the customer experience and grow business internationally.

The success in Spain may also open up a number of opportunities for Landis+Gyr, according to Sanchez Fornie: "Landis+Gyr has been an important enabler in the development of our PRIME technology from start to finish and is a reliable and customer-focused supplier. The performance of Landis+Gyr PRIME meters within Iberdrola's smart grid is second to none." Landis+Gyr plans to offer its PRIME meters to Portugal and other potential markets that opt for the PRIME standard. ■

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Iberdrola STAR statistics to date (September 2016):

PRIME smart meters now in operation:	**8,069,951**
Smart secondary substations in operation:	**45,322**
Remote operations success rate:	**99%**
Average round-trip latency:	**17 seconds**

Number of smart transactions in 2015:

Bills issued through smart metering:	**49,231,749**
Remote disconnection orders:	**129,612**
Remote reconnection orders:	**110,869**
Power limit change orders:	**115,350**

Environmental impact in 2015:
Iberdrola was named the most sustainable Spanish utility and the third-most sustainable utility in the world by Newsweek magazine, which cites the use of smart meters to help reduce carbon emissions.

www.metering.com/iberdrola-cuts-power-outages-in-spain/

Netze BW and Landis+Gyr promote digitization in Germany

For decades Germany has played a pioneering role in transforming the way energy is generated, distributed and consumed in Central Europe. Thus it should come as no surprise that a major utility company in the state of Baden-Wuerttemberg is leading the trend to increased digitization in the energy market.

EnBW

About EnBW

EnBW Energie Baden-Wuerttemberg AG was founded in 1997 and is one of the largest energy suppliers in Germany and Europe. With a workforce of some 20,000 employees, EnBW provides utility-related products and services to 5.5 million customers. The company promotes the "energy turnaround" in Germany with the slogan "Energiewende. Sicher. Machen."

Its subsidiary Netze BW GmbH has some 3,500 employees who are responsible for the safe and efficient distribution of electricity, gas and water for most of Baden-Wuerttemberg. The subsidiary delivers electricity to 2.65 million customers.

www.enbw.com/company/index_en.html

EnBW, with headquarters in Karlsruhe, is revolutionizing the management of renewable energy sources through its subsidiary network operator Netze BW and advanced technology from Landis+Gyr. The project involves the installation of 3,000 S750 grid modules from Landis+Gyr to manage decentralized renewable energy sources in the 100 kW to 1 MW range. The first units were laboratory tested and then installed in several photovoltaic plants. Now the rollout is ongoing.

EnBW has been relying on project expertise from Landis+Gyr for decades. This particular development is just one of many milestones that have been achieved through the collaboration of both companies. What's more, the unique aspects of the German energy market, and the regulatory legislation governing energy generation and distribution throughout the country, have also been significant factors that have encouraged partnerships in research and development among utility companies and other leading market players.

An alliance for the future of energy

In 2000, the German parliament passed the Renewable Energy Sources Act, or EEG (Erneuerbare-Energien-Gesetz)[15] as a first step toward modernizing and deregulating the energy market, especially in the area of electrical power generation. Utility companies and policymakers had long been aware of the fact that changes needed to be made in the way energy is produced, managed and consumed. Dwindling fossil fuel sources, concerns about the consequences of nuclear power and the importance of preserving the environment by reducing CO_2 emissions were key factors that would eventually reshape the future of the energy market, which had been governed by a rather simple "supply and demand" business model followed by a limited number of players.

The EEG was intended to diversify and open up the market, enabling small renewable energy companies to compete on a level playing field. This was a remarkable paradigm shift that revolutionized the energy market – by moving from a centralized structure to a diverse and decentralized approach.

But this development also had a side effect. Diverse and deregulated energy generation, distribution and even consumer billing are very complex matters that require innovative technologies for metering and managing loads and grids. Communicating information and tracking key data in real time were completely new aspects. Prices for renewables also vary, and grid operators needed to have mechanisms for balancing their power generation to ensure price and delivery stability. These and many other factors called for new approaches to energy management at all levels. And this is what led to the long-term business partnership between EnBW and Landis+Gyr.

Innovation through shared expertise

In response to the challenges posed by the dramatic change in energy policy, Germany's three leading utilities – EnBW, RWE, and E.ON – formed a consortium to launch the SyM² (Synchronous Modular Meter)[16] project. The purpose of the initiative was to establish open standards that would lead to the development of smart meter technology to replace proprietary and incompatible metering systems. In light of more than a century of innovation in the field of electrical technology, Landis+Gyr was selected by the consortium to support the SyM² project with in-depth research and manufacturing expertise.

In addition to optimizing utility processes, smart technology would be expected to handle network management, customer service functions, the management of grid processes and microgeneration. Interoperability and easy installation were also key parameters. To deliver this kind of functionality, smart meters and modules would need to provide authentic data in real time, be completely based on IP communication and feature open modularity.

15 Renewable Energy Sources Act: www.bmwi.de/EN/Topics/Energy/renewable-energy.html
16 Synchronous Modular Meter Project: www.docplayer.net/9869342-General-specification-for-synchronous-modular-meters.html

Landis+Gyr came up with a unique multi-modular metering solution, the SyM^2-E750 smart meter. In addition to meeting project specifications, the Landis+Gyr technology represented a cost-effective method of providing the entire market with affordable systems and freedom of choice through open standards, not to mention easy provisioning and installation.

More than a decade of development of future-proof technology

The launch of the GM-EEG (S750) by Netze BW is a logical extension of decades of collaboration as Landis+Gyr continues to enhance this groundbreaking SyM^2-based technology with advanced features and new system devices. “We were looking for a customized solution that would provide the right compatibility and communication technology for this project, namely the SyM^2-compliant Ethernet Bus communication module (SyM^2-CU) GSM/GPRS, and Landis+Gyr’s S750 grid module delivered just that,” says Enrico Lang, Technical Project Manager at Netze BW. The first modules were installed in the town of Wendlingen in August 2015 in a rooftop photovoltaic array run by EnBW directly. With an output of 800 kW, it is the perfectly sized facility to act as the test bed for the new technology. The technology rollout will continue throughout the utility’s photovoltaic generation facilities in Baden-Wuerttemberg. The S750 grid module is a crucial component of the solution for managing the electric feed-in from large and medium-sized solar, wind, and other renewable energy power plants in conjunction with SyM^2-based modular metering platforms for commercial and industrial customers.

The S750 grid module also allows companies to retrieve real-time information from individual solar generation facilities, enabling quick responses to changing grid conditions. “Thanks to the S750, data can be communicated in real time. What’s more, active and reactive power can be switched and controlled as required. The plants controlled by this module are easily integrated in our SCADA system infrastructure,” adds Selma Lossau, Project Manager for S750 Grid Module at Netze BW. “The S750 complies with the new regulations that took effect on January 1, 2016, which require that all decentralized energy sources with an output of more than 100 kW are required to have functionality that allows the energy generated to be distributed to the network directly. – that’s why it’s the best future-proof solution for us.”

The energy market in Germany is advancing at a remarkable pace, and the microgeneration of renewable energy is booming as never before. Policy makers and utility companies are under constant pressure to ensure that market conditions provide for the secure, balanced and affordable provision of electricity based on an increasing share of renewables. This can only be achieved through digitization, which is why Landis+Gyr continues to focus on intelligent metering and grid solutions that boost efficiency, provide transparency and promote customer involvement to support the “energy turnaround” in Germany.

Digital technology sustains intelligent energy management

The EEG has been revised many times over the past 15 years; the most recent change in energy policy was enacted on July 8, 2016, with the passing of the Act on the Digitization of the Energy Transition by the German parliament (see information box). Among other things, this legislation mandates the technical specifications that will apply to energy management in the digital age, and it aims at having up to 80 percent of all end consumers using smart metering solutions in the future. Another significant aspect of the law is data security and data privacy, which must be ensured in all metering and grid technologies that will be installed in the future. ■

Act on the Digitization of the Energy Transition (2016) – Federal Republic of Germany

The purpose of the Act on the Digitization of the Energy Transition (Gesetz zur Digitalisierung der Energiewende) is to support the harmonization and orchestration of electric power grids, power generation and consumption using modern digital technology. The legislation defines the technical specifications for smart metering solutions. Mandatory directives for ensuring data privacy and interoperability are also specified in the law.

Intelligent metering systems must fulfill all of the specifications defined by the Federal Office for Information Security (Bundesamt für Sicherheit in der Informationstechnik – BSI). Digital metering solutions must provide for reliable data capture, processing and communication, along with secure protocols, storage and data deletion processes for information originating from smart metering. Transparent energy consumption data for customers is also mandated. The provisions of the law apply to consumption of levels of 6,000 kWh or more annually.

digitization

Historically, distribution networks have not been equipped with high levels of automation – but market dynamics and the advent of smart grid technologies are rapidly changing this. Nowadays, energy generation and distribution rely on advanced digital technologies and intelligent devices to satisfy customer demands and business requirements. To the distribution system operator, digitization is the key to new distribution automation technologies for better performance.

– the driver of distribution automation for smart grid operations

By definition, distribution automation (DA) by definition applies to any automated characteristics and functions in distribution networks that carry energy from DSOs to industrial and residential users. DSOs are responsible for operating, maintaining and developing secure, reliable and efficient electricity distribution networks. This is quite challenging because the supply chain is extremely complex. For example, the requirements of urban and industrial areas are much more demanding than those found in rural areas where there is lower consumer density. Furthermore, the substation assets needed to serve a diverse range of consumers also vary considerably and are comprised of rather expensive components. In older environments with very little automation, the number of potential weak spots at substation level has been traditionally high, making the risk of failures and outages difficult to forecast. In addition to huge investments in assets, DSOs are also faced with the high costs of the manpower needed in the field to maintain substation equipment and respond to outages or failures, both day and night.

The impact of renewable energy sources

Innovative technologies for local and low-cost renewable generation – often funded with support from national governments – have resulted in a significant market penetration of renewables and distributed generation in many countries. This and a broad emerging range of distributed energy resources (DER), plus growing demands for local storage and better overall utility response, require significant changes in the planning and operation of electricity distribution systems. Thus DA solutions play a vital role in helping DSOs plan, develop and manage their distribution networks in a more secure, reliable and cost-effective way. A number of approaches are already being taken to make distribution fit for the future – for example: optimized fault management to reduce power outages; fast fault location, isolation and service restoration (FLISR); smart transformer and feeder monitoring for better grid investment planning and expansion management; integrated distributed generation and Volt/VAR control to immediately localize and resolve issues that could cause limit fluctuations and serious outages.

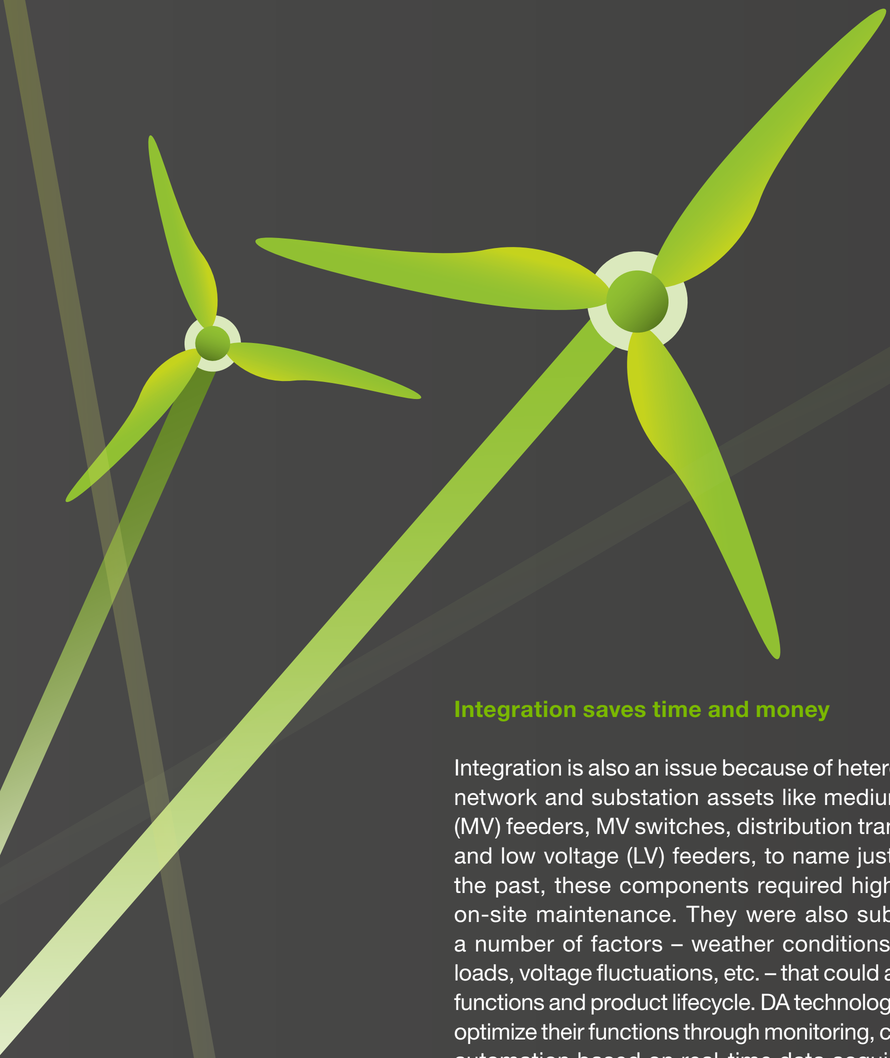
Orchestration is essential for successful DA

Distribution automation solutions are based on two functional levels. The primary level involves the assets and devices at substation points that can be programmed and automated to perform specific tasks – switches, breakers, reclosers, data communication systems, RTUs, etc. The secondary level involves processing the data arriving at a central control center (e.g., SCADA) to coordinate the actions of the primary devices. The interaction of these two levels must be orchestrated to achieve maximum performance. Thus, reliable and secure communication systems are required to send and receive information that is transmitted from substation assets to central control instances – and vice versa. Today, typical technologies – both wired and wireless – are used, ranging from fiber optics, microwave, GPRS, multiple radio formats, WiMAX, powerline carrier, etc. These technologies, however, also rely on diverse communication protocols that include Ethernet, TCP/IP, DNP3, IEC 60870-5-104 and IEC 61850. DSOs must also make sure that the entire communications infrastructure is absolutely secure so that no breaches occur that could result in data loss or theft. Security solutions for DA applications should be based on a holistic approach that combines innovative safeguards along with traditional protection such as public key infrastructure (PKI) technology and authentication mechanisms in compliance with industry standards (please see the security article on page 18).

Establishing and maintaining reliable real-time data communications between SCADA systems and the DA solutions in substations can be difficult. Communication networks are exposed to severe environmental conditions, electromagnetic interference, lightning and power outages, not to mention potential security issues. The costs for modern communication systems can be quite high, making utility investment decisions difficult. It is important that planners evaluate the initial cost in conjunction with lifetime operation and maintenance expenditures when choosing communication systems and protocols. The DSO must strike a balance between total costs and overall performance when deploying a sustainable DA solution for the long term.

Enexis case study: Distribution Automation in action:

www.landisgyr.eu/resource/case-studies/



Integration saves time and money

Integration is also an issue because of heterogeneous network and substation assets like medium voltage (MV) feeders, MV switches, distribution transformers and low voltage (LV) feeders, to name just a few. In the past, these components required high levels of on-site maintenance. They were also subjected to a number of factors – weather conditions, extreme loads, voltage fluctuations, etc. – that could affect their functions and product lifecycle. DA technology can help optimize their functions through monitoring, control and automation based on real-time data acquisition and multidirectional communications. This information is evaluated centrally to keep track of equipment status and to allow for remote adjustments as needed. In fact, as digitization continues to transform the market, DA devices are starting to communicate not only with the SCADA, but among themselves as well, leading to the development of many more self-healing components and systems. DA has already enabled utilities to improve their services thanks to better utilization of distribution network assets and the deferral of potentially premature network investments.

Aging infrastructures, however, cannot be transformed overnight. No DSO is in a position to make the massive investments needed to digitize entire distribution landscapes. Digitization is a gradual process that must be conducted realistically. As DSOs update or upgrade their assets, many replacement components will already have DA functionality that allows for effective integration in SCADA/DMS systems. In fact, aging infrastructures represent an opportunity because DA enables DSOs to extend the lifetime of existing assets and derive value from them for a longer period.

Intelligent use cases for enhanced energy distribution

DA solutions are essential elements for deploying applications that support intelligent service enhancement. For example, load forecast and modeling is a predictive approach to making precise load forecasts and models in real time or near-real time. Data is gathered at the substation, service transformer or meter level to reflect the consumption patterns of specific customer groups. This is important for network planning that will boost distribution reliability and efficiency based on factors like demand, power load, diversity and degree of utilization over specified periods. When it comes to distributed energy resources and renewables, DA also supports distributed generation management to mitigate the risk of power losses, congestion and outages while controlling the voltage profile and reactive power generation. This is vital for managing smart grids, microgrids and the flexible decentralized or modular grids that are growing in importance. If an outage or incident should actually threaten a network, DA technology will support fault detection, isolation and restoration (FDIR), which uses algorithms for identifying and locating faults in the distribution system. It also restores power to those located in the outage areas through transfers to neighboring circuits. Customer minutes lost (CML) can be reduced from hours down to minutes while the System Average Interruption Duration SAIDI/System Average Interruption Frequency (SAIFI) Indices improve. As a result, DSO performance is enhanced through improved system reliability and availability of service.

Data-centric companies

“In the past, DSOs were asset-centric companies that physically managed distribution infrastructure assets such as power lines, switchgear, substations and transformers,” says Javier Rodríguez, Business Development Manager, Landis+Gyr. “With the transformation of these environments into smart grids, however, their asset base is being expanded to include DA devices such as intelligent monitors and sensors, not to mention smart meters. Thus DSOs are becoming data-centric companies, using digital technologies to optimize asset management, integrate distributed renewable energy resources and improve network stability and security.” Today, knowledge of software development and deployment, system scalability, remote and automated maintenance and recovery,

Landis+Gyr smart grid technology for DA solutions

In fiscal year 2015–2016, Landis+Gyr invested 9.3 percent of sales revenue in research and development projects to enhance the company's technology portfolio. Landis+Gyr smart grid technology empowers utilities to move beyond smart metering to experience the benefits of sensing, distribution automation and grid analytics for reliable and affordable future-centric energy scenarios.

The Landis+Gyr S760 Smart Grid Device Integrator is a MV/LV monitoring and control solution that creates a cross-functional smart grid platform through seamless integration of all substation devices in both the existing SCADA and any new IT systems deployed.

The Landis+Gyr S650 SCADA is a MV/LV monitoring and control solution integrating the functionalities of the S650 Smart Grid Terminal with the advanced communication capabilities of the multiprotocol SmartCom Remote Terminal Unit (RTU). The S650 SCADA aggregates and transmits real-time data to the AMI/AMR, DMS/SCADA or any other grid management system, enabling smooth integration and control of renewables and microgeneration, plus monitoring and control of secondary MV/LV transformer stations.

For details visit: www.landisgyr.eu

plus compliance with industry and security standards are key to business success. The communication chain serves as the backbone joining hardware and intelligent modular devices in the field with various host applications and SCADA management of broad distribution networks. Hence, expertise in future-proof data communications is of great importance. "DA projects are not based on technology alone," says Rodriquez. "They require experienced professionals and industry partners dedicated to designing, realizing and managing future-centric technology to ensure that DA delivers a good return on investment through optimized performance."

Measurable benefits for all stakeholders

Once implemented, DA delivers a number of measurable benefits for both providers and customers. Smart devices and self-healing grids result in dramatic improvements in the SAIDI and SAIFI, which promise virtually outage-free service while reducing the number of technicians working in the field. Optimized capacity management boosts operational efficiency by cutting energy losses and limiting periods of peak demand. Intelligent control also keeps distortion and voltage fluctuations at low levels – this enhances performance while also extending the lifetime of substation assets. When it comes to renewable energy sources, DA is instrumental when integrating DER in grids while also maintaining stability. In fact, ongoing developments in digitization are among the drivers behind the adoption of more renewables in the energy mix. And since distribution automation allows for a gradual transition to more intelligent technologies, DSOs are not faced with massive investments and construction costs for new substation equipment and sites. The deployment of DA – either as new installations or retrofit upgrades – reflects major advancements in terms of design, systems, substation equipment and devices that make networks agile, efficient and future-proof. In short, the bottom line is better performance, lower costs, more reliability and improved transparency for all stakeholders. ■

Watch our video case studies here:

www.landisgyr.eu/resource/videos

green news: all about energy

Energy efficiency ranking

In July 2016, the American Council for Energy-Efficient Economy (ACEEE) released their annual report “The 2016 International Energy Efficiency Scorecard.” The report rates the 23 nations with the highest energy consumption on the planet, assessing their commitment to energy efficiency. With a score of 73.5 out of a possible 100, Germany came in first place, followed by Japan and Italy, both with 68.5 points, France with 67.5 points and the UK with 65 points. The USA came in eighth place, with 61.5 points.

Countries are given points based on political instruments such as national energy-efficiency goals as well as concrete consumption data, including fuel consumed by private vehicles and energy consumption per square meter in homes. Performance metrics are collected in four categories: buildings, industry, transportation, and overall national energy efficiency efforts. EU nations scored well for their ambitious energy efficiency goals, while Germany’s final score was significantly influenced by its incentives and support for energy-efficient renovation projects. Italy scored highest in the transport sector, due to large scale investment in the national rail network.

Find out more: http://aceee.org/research-report/e1602

Around the world with solar power

After flying more than 40,000 kilometers, the solar-powered aircraft Solar Impulse 2 touched down in Dubai on July 26, 2016, marking the end of its year-long flight around the world. The two Swiss pilots Bertrand Piccard and André Borschberg took turns at the controls on the 17 stages of their long journey, starting in the United Arab Emirates and touching down in India, China, Japan, the USA, Spain and Egypt before returning to the UAE. The two longest stages were crossing the Pacific Ocean, a journey of 7,212 km, and the Atlantic Ocean, a flight of 6,765 km. The plane’s solar cells generated 2,409 kWh over the Pacific and 1,388 kWh over the Atlantic to power the four engines, flying at a top speed of 75 kmh. Over the course of the entire journey, the plane generated 11,655 kW/h of electricity.

Solar Impulse 2 has a wingspan of 72 meters and weighs only 2.3 tons. 17,248 individual wing-mounted solar cells generate the necessary power for flight, which is stored in four batteries, allowing the aircraft to stay in the air both day and night.

Sources: www.solarimpulse.com/adventure

Sources: www.eafo.eu/content/eafo-press-release-europe-has-more-500000-electric-vehicles-road; www.eafo.eu/europe www.welt.de/wirtschaft/article156069930/Schon-2025-koennten-nur-noch-E-Autos-zugelassen-werden.html?config=print

E-Mobility catching up in Europe

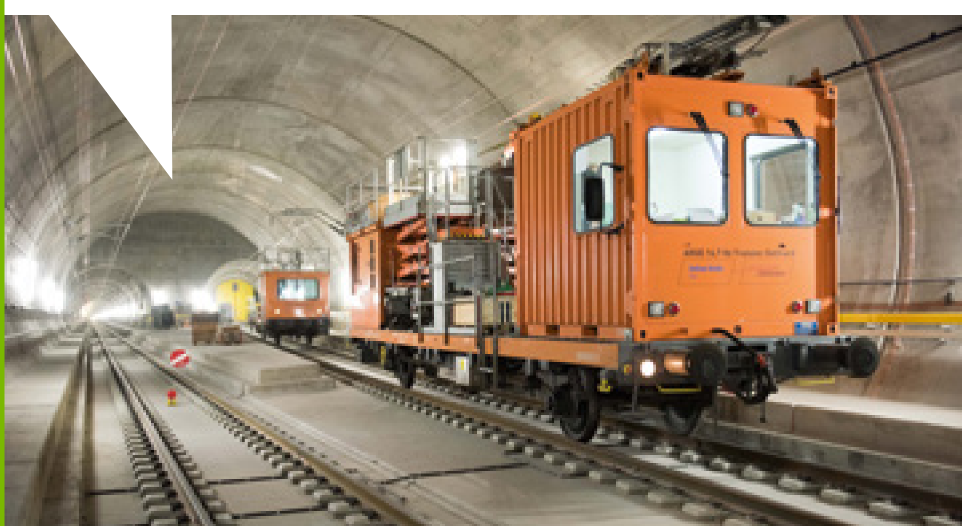
In June 2016, a total of 476,377 electric cars were on Europe's streets. So far in 2016, 95,600 new electric cars have been registered, up by 17,755 compared to the same time last year. These figures were released by the European Alternative Fuels Observatory (EAFO), who estimate that registrations will pass the half-million mark in August. The leading countries in electric mobility are Norway, the UK and France, where new registrations in June 2016 in each country were up by more than 30 % from the previous year – in France, 57% higher than 2015. The number of electric cars is also rising in most other European countries, including Italy, Germany and Sweden.

At the same time, E-mobility is becoming an increasingly important topic of debate in the world of politics. Norway is already encouraging the use of electric vehicles by offering free city-center parking and free charging at public charging stations. Discussions are ongoing in Norway's parliament about offering further incentives for citizens to become electrically mobile – for example by only allowing new car sales of vehicles that run on electricity or fuel cells, starting in 2025. Similar projects in other countries go even further, proposing a total ban on cars that run on fossil fuels, for example, in the Netherlands from 2025 and in India from 2030. Germany recently introduced legislation to subsidize the purchase of electric vehicles.

Swiss engineering underground

At the beginning of June this year, the Gotthard Base Tunnel in Switzerland was officially opened, bringing an end to a groundbreaking 17-year construction project. Taking its place in the record books as the longest railway tunnel in the world, the new rail route passes underneath the Saint-Gotthard Massif, connecting Erstfeld in the Canton of Uri to Bodio in the Canton of Tessin, thus significantly shortening the AlpTransit line, the north-south rail connection through the Alps. At 57 km long, the Gotthard Base Tunnel is longer than the Seikan Tunnel in Japan (53.8 km) and the Eurotunnel under the English Channel (50.5 km).

The tunnel is packed with high-tech equipment to provide high-voltage electricity to power the trains, as well as telecommunication and safety systems. All of this needs power, and various electrical cables carry power for different purposes. Just to drive the trains that will use the tunnel, 3,200 km of cable was laid to deliver 16.7 Hz electricity from the high-voltage network of the Swiss rail provider, SBB. The railway electrification system has been equipped with the special model Landis+Gyr E850 grid meters for energy measurement and billing. A second network delivers electricity at 50 Hz for general purposes. A safety system uses a turbine to constantly pump water through drainage channels. In case of an accident, this will prevent any spilled fuel or oil from catching fire, and as a positive side-effect, the running water generates enough electricity to power 100 homes for a year.



Source: www.bbc.com/news/world-europe-36423250

Read more in our blog:

eu.landisgyr.com/blog

Issue 7, October 2016
pathway is published by
Landis+Gyr AG
Theilerstrasse 1, 6301 Zug, Switzerland
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Photography:
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Additional photos by Landis+Gyr/Seidl PR & Marketing GmbH

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