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GEODE REPORT

Digitalisation of Distribution Grid Operation

Introduction

Digitalisation is reshaping the energy sector, presenting unprecedented opportunities to enhance grid operations, improve efficiency, and support the transition to a cleaner, more sustainable energy system. Recognising the critical role of Distribution System Operators (DSOs) in this transformation, GEODE, the association representing local energy distributors across Europe, has developed this report to assist DSOs in navigating their digitalisation journey.

The report emphasises the importance of leveraging digital technologies to tackle these challenges effectively. Smart grids, grid automation, demand-side management, predictive maintenance, digital twin technology, and enhanced customer service are just a few of the solutions that can empower DSOs to meet the demands of a rapidly evolving energy landscape. Last but not least, the report also highlights the critical need for robust cybersecurity measures, workforce optimisation, and improved data utilisation.

With the **primary goal of identifying the key challenges and opportunities DSOs face as they digitalise their networks**, the report is designed to serve as a practical guideline, offering valuable insights for DSOs embarking on or advancing their digital transformation efforts. In addition, the report puts forward strategic recommendations that provide a clear roadmap for digitalisation, encompassing steps such as assessing current capabilities, piloting digital solutions, scaling successful projects, fostering collaboration, and leveraging EU funding mechanisms.

Finally, the annex showcases best practices from across Europe, illustrating successful digitalisation initiatives that have driven measurable improvements in DSO operations.

The Challenges of Operation and Planning of Distribution Networks

The transition towards digitalisation poses a multitude of challenges for DSOs. As they strive to modernise networks and integrate new technologies, they must navigate a complex array of technical, operational, and organisational hurdles. These challenges arise from the increasing demands of the energy transition, the growing penetration of renewable energy sources, new loads and volumes and the need to balance innovation with reliability and the increasing expectations of stakeholders for improved data, information and transparency.

IDENTIFIED CHALLENGES

The increasing integration of renewable energy sources, especially intermittent ones such as solar and wind, has transformed modern power grids. While these sources bring sustainability and reduced carbon emissions, their variable and distributed nature introduces technical complexities that grid operators must address.

In addition to renewables, the growing adoption of energy storage systems and electric vehicles (EVs) is reshaping grid dynamics. Storage systems provide much-needed flexibility by absorbing excess generation and supplying power during periods of low renewable output, helping to smooth out fluctuations. Meanwhile, EVs introduce both challenges and opportunities: unmanaged charging can strain local networks and exacerbate peak loads, but with smart charging and vehicle-to-grid (V2G) technologies, they can act as distributed storage assets that support grid.

Grid congestion	As electrification accelerates and the grid accommodates an increasing volume of decentralised assets, system congestion is emerging as a critical operational challenge. These bottlenecks limit the ability of DSOs to provide all the energy flows desired by customers. Digitalisation allows DSOs to identify such bottlenecks much more accurately and efficiently and provides the ability to use flexibility to manage energy flows, particularly during peak demand or high generation periods.
Voltage Fluctuations	Addressing voltage fluctuations requires advanced monitoring systems capable of detecting real-time variations, as well as automated control mechanisms to balance reactive power and maintain voltage within safe margins. DSOs must therefore deploy new assets and tools to ensure that localised voltage deviations do not propagate through the network. The use of real-time data analytics and predictive forecasting further enhances DSOs' ability to mitigate voltage instability proactively.

Grid Stability	Renewables' variability means that traditional centralised generation and load forecasting models are no longer sufficient. DSOs play a vital role in ensuring system resilience by actively managing congestion points and preventing bottlenecks that could lead to cascading failures. Key strategies include leveraging energy storage systems to absorb excess generation during periods of low demand, deploying flexible demand response programmes, and enhancing grid flexibility through digitalisation and automation. Coordination with transmission operators and other stakeholders is also relevant to maintain a secure and efficient energy flow across all grid levels.
Ageing Infrastructure	Many European distribution system assets are reaching the end of their operational lifespans, creating a significant financial challenge. By 2050, up to 90% of the EU's grids could be over 40 years old if investment does not accelerate. However, this investment necessity also presents a major opportunity: with the right funding, grid renewal can go beyond simple replacement. It offers the chance to build a more efficient, digitalised, and resilient infrastructure, better suited to the demands of the energy transition[1].
Lack of Smart Grid Technologies	The adoption of smart grid technologies remains inconsistent across DSO networks and EU Member States, creating gaps in network visibility and control. This limits DSOs' ability to respond proactively to dynamic energy demands and integrate distributed resources efficiently.
Real-Time Grid Visibility and Control	Operating a modern grid demands comprehensive, real-time monitoring and intelligent control systems. Real-time data on power flows, voltage levels, and equipment status enables grid operators to respond quickly to demand fluctuations, renewable generation variability, and emerging congestion points. By integrating granular, real-time visibility with automated control actions, DSOs can maintain a resilient, efficient, and secure grid as energy systems become more decentralised and digitalised.
Demand-Side Management	Effectively managing demand in the context of increased electrification requires sophisticated planning and consumer engagement. DSOs face the challenge of monitoring and controlling (directly or indirectly) flexible demand-side resources while maintaining network stability.
Data Management and Interoperability	Digitalisation generates massive volumes of data from smart meters, sensors, and grid automation devices. DSOs need robust data management systems capable of processing, analysing, and securely sharing this data across various platforms and stakeholders. Ensuring interoperability between legacy systems and modern digital tools is a significant technical hurdle.

[1] https://powersummit2024.eurelectric.org/grids-for-speed/

Connection Requests Management	The surge in requests for new connections, particularly for renewable energy installations (photovoltaic solar panels) and electric vehicle charging points, places new strains on network planning and operational processes. Digitalisation provides opportunities to streamline the connections application process, automating and simplifying the transfer of necessary data and information between customers and DSOs, as well as providing much better data for customers on the progress of their applications. There is also scope for similar improvements in the efficiency of transferring compliance data and certifications, where this is required, between customers and DSOs.This activity is likely to grow in the future, as the growth of smart appliances requires more compliance data to be exchanged between customers (or their agents or even manufacturers) and the DSOs.
Cybersecurity Concerns	As grids become more digitalised and interconnected, they become increasingly vulnerable to cyber threats. Ensuring robust cybersecurity measures and maintaining secure communication systems is a critical challenge for DSOs.

Customer Engagement	Engaging customers to actively participate in energy management—such as demand response schemes, energy efficiency measures, and optimised consumption patterns—remains a key challenge. DSOs must find ways to educate and involve customers in these initiatives while fostering trust and collaboration. The growth of digitalisation in network management, and also in customer management/information systems, provides opportunities to automatically provide significant helpful information to customers during system events, such as unplanned DSO outages. Customers can be kept up to date with the DSO's progress in rectifying problems and with estimates of when supplies might be restored. Such initiatives can provide significantly improved customer service during high stress events, such as severe storms where many thousands of customers may be affected.
Regulatory and Compliance Pressure	Digitalisation must be aligned with evolving regulatory frameworks focused on decarbonisation, grid reliability, and consumer empowerment. DSOs face the challenge of integrating new technologies while meeting strict regulatory requirements and adapting to shifting market designs.

Digital Solutions to Overcome Challenges and Unlock New Opportunities

There are key digital tools and technologies that can help DSOs overcome operational, planning, and customer-facing hurdles while unlocking new efficiencies and service opportunities. From smart grids and energy management systems to digital twins and artificial intelligence, these innovations provide the foundation for a more flexible, resilient, and responsive electricity distribution network.

SMART GRIDS

Smart grid systems represent a fundamental evolution in electrical grid management, integrating advanced technologies such as automated metering infrastructure (AMI), sensors, and Internet of Things (IoT) devices to monitor and control energy flow in real-time, integrating not only data from the grid, but also external data such as weather, load and generation forecasting, etc., to better plan the grid operation.

This digital infrastructure enables more efficient electricity distribution, the reduction of network losses, and facilitates the integration of renewable energies, while providing consumers with detailed information about their energy consumption. Additionally, Smart Grids improve system reliability through early fault detection and self-healing capabilities, thus contributing to a more resilient and sustainable electricity system.

GRID OPERATION AUTOMATION

Grid automation technologies, powered by Advanced Distribution Management Systems (ADMS), are transforming traditional power distribution by implementing intelligent systems that enable autonomous operation and real-time monitoring of substations and distribution networks. ADMS serves as the central nervous system, integrating various automation functions into a unified platform for comprehensive grid management.

With the increasing digitalisation of grids, manual operation has become increasingly challenging due to the massive amount of data and complex analysis required for decision-making related to the operation of the grid. ADMS addresses this challenge by providing advanced analytics and automation capabilities, making it essential for grid operators in their daily tasks. The system processes vast amounts of real-time data from field devices, sensors, and existing system control and data acquisition (SCADA) systems, converting it into actionable intelligence.

These advanced systems enhance operational efficiency through automated fault detection, isolation, and service restoration, significantly reducing outage times and improving overall grid reliability. The ADMS platform further augments these capabilities by providing advanced power flow analysis, voltage optimisation, and predictive maintenance functionalities. Furthermore, automated substations, orchestrated through ADMS, facilitate better power quality management and load balancing, maximising grid utilisation and efficiency while enabling seamless integration of DER.

DEMAND-SIDE MANAGEMENT AND ENERGY MANAGEMENT SYSTEMS (EMS)

To make use of demand-side flexibility, DSOs need two elements: access to the flexibility itself and a system to manage it. Flexibility can be sourced through bilateral agreements with customers or via market platforms offering a simplified, centralised option. While agreements require strong local engagement, markets depend on liquidity. Both sources require smart metering for reliable and accurate functioning.

Once flexibility is available, Energy Management Systems (EMS) are essential to put it into action. EMSs must detect current and forecast future grid conditions — such as congestion or voltage issues — using data on consumption, generation, and grid configuration. This requires close coordination with TSOs, neighbouring DSOs, and other stakeholders, and the secure flow of data into DSO systems.

With this foundation in place, EMSs can help DSOs automatically activate flexibility by defining operational limits and responding in real time. This enables a more proactive, efficient, and local approach to grid management, helping DSOs avoid costly reinforcements while supporting a smarter, more responsive energy system.

EMSs will develop rapidly as the scale of data explodes. EMSs can collect information from the whole system and customers from sensors inside and outside the grid, smart meters, and behind the meter sensors. By integrating all available data with artificial intelligence, EMSs can offer a fundamentally new level of observability of the power systems when compared to current technologies, as well as function as distributed energy resource management systems.

PREDICTIVE MAINTENANCE AND ASSET MANAGEMENT

Leveraging data analytics and artificial intelligence (AI) to predict equipment failures and extend the lifespan of assets is transforming the power industry. By continuously monitoring and analysing data from various sensors and systems, predictive maintenance can resolve potential issues before they escalate into costly failures. This proactive strategy not only enhances the reliability and efficiency of the electrical grid but also optimises maintenance schedules, minimises downtime, and maximises the operational life of critical infrastructure. As a result, energy providers can achieve cost savings and deliver even more consistent and reliable services to their customers.

DIGITAL TWIN TECHNOLOGY

A Digital Twin is a dynamic virtual model of the distribution grid that integrates real-time data, historical records, and analytical models to mirror the state of the network. It enables DSOs to simulate different scenarios, monitor, and analyse grid operations in real time, anticipate issues such as congestion or faults, and test the impact of changes before acting. This improves decision-making, allows better planning, supports the integration of distributed energy resources, and enhances network optimisation, operational efficiency and safety.

Beyond operations, Digital Twins play a key role in planning and asset management. By using sensor data and predictive analytics, DSOs can shift to condition-based maintenance (CBM), allowing maintenance activities to be triggered by the actual health and performance of network components, rather than by fixed schedules, optimising resource use, reducing unplanned outages, and extending asset lifespans. In ageing or heavily loaded grids, this is particularly critical to ensure reliability and cost-efficiency.

As grids become more complex, the Digital Twin becomes a vital tool offering the visibility and insight needed to manage today's challenges and prepare for tomorrow's demands.

CYBERSECURITY SOLUTIONS & DATA PROTECTION

The energy sector has become a prime target for cyberattacks due to its strategic importance. Threats such as ransomware, phishing, and advanced persistent threats can severely disrupt grid operations, leading to outages, economic losses, and compromised public trust. For DSOs, the integration of smart grids, IoT devices, and decentralised energy resources expands the possible attack surface and the complexity of defending critical systems. To address these challenges, the EU has established a strong regulatory framework, including the NIS 2 Directive, General Data Protection Regulation (GDPR), the Network Code on Cybersecurity (NCCS) and the upcoming Cyber Resilience Act (CRA). An Information Security Management System (ISMS), aligned with ISO/IEC 27001 or equivalent frameworks and often supported by other standards (e.g. IEC 62443 and ISO 22301), provides the necessary structure to ensure that security efforts are measurable, auditable and future-proof. Cybersecurity is no longer just an IT issue, but a core aspect of distribution network operations. Protecting infrastructure, information and data is not only essential for compliance but also for enabling a secure, reliable, and digitally connected energy future in Europe.

WORKFORCE AND FIELD MANAGEMENT

Digital scheduling and management of labour and resources, together with enhanced data for customer service and for identifying efficiencies, are indispensable in enhancing process efficiency, minimising sources of error and optimising HR management. In this sense, digital workforce management systems can optimise field crew scheduling and dispatch, while virtual reality (VR) and e-learning platforms can help upskill staff in new digital tools and grid technologies.

For example, at Wiener Netze, an Austrian DSO, customer requests are documented in an enterprise resource planning (ERP) system, which can also serve as a customer relation management system. The ERP system also encompasses the grid asset database, enabling the linking of grid assets with customer requests. To this end, project implementation and documentation are managed within a single system. Furthermore, specific work orders are formulated under the project, which are assigned to a dispatcher. The dispatcher ensures that the work order is allocated to the appropriate employee, who can receive, process, and report back on the task using a mobile device. Consequently, adjustments to the master data are made directly in the asset management database. In summary, digital workforce management is indispensable in enhancing process efficiency, as sources of error are minimised and the efficiency of staff allocation is enhanced.

ENHANCED CUSTOMER SERVICE

AMI has revolutionised the DSO's possibilities for enhanced customer service. Through continuous data acquisition and the employment of AMI meters, a DSO has the ability to manage energy data and provide this data to their customers almost in real-time.

Customer surveys and interviews are essential for identifying customer needs and challenges. Based on the exploration of the customer demand, a DSO can develop

and provide innovative solutions and services to best address these needs. Novel solutions based on AMI and other data can provide visual and illustrative information to customers: for example, on their electricity usage and their available free capacity.

Based on visual information, customers can easily assess, for example, how many EV charging points or solar panels they can install on their premises. Digital customer portals and mobile apps enable DSOs to provide real-time service updates, outage notifications, and usage insights, empowering consumers to actively engage in the energy transition.

EXCHANGE OF INFORMATION

A key enabler of enhanced customer service is the availability of near real-time electricity usage data through smart meter readings. However, to enable effective two-way digital communication between the DSO and the customer, smart metering must be complemented by integrated customer service and metering data systems, along with robust data exchange mechanisms. While many European countries already have access to smart meter data, the 2025 ACER report *Unlocking Flexibility: No-Regret Actions to Remove Barriers to Demand Response*[2] emphasises the need to accelerate the smart energy transition, calling for the widespread deployment of smart meters and ICT services to empower consumers to respond intelligently to energy signals.

ARTIFICIAL INTELLIGENCE

Artificial intelligence is transforming the way electricity is distributed and used in homes and businesses, especially in Europe, where the push for greener, more decentralised energy is accelerating. AI not only helps utility companies to optimise grid performance, but it also opens new opportunities for consumers to interact with electricity in a simpler, smarter, and more convenient way.

By analysing consumption patterns, weather forecasts, and electricity prices, AI can help consumers make informed decisions about how and when to use energy. For example, it can suggest the best time to run appliances, charge an electric vehicle, or use a home battery. This not only saves money on the bill but also helps stabilise the electricity grid.

But beyond savings and grid optimisation, AI offers a more personalised and user-friendly energy experience. Using natural language interfaces, virtual assistants can explain bills, compare rates, track consumption habits, and recommend actions to reduce environmental impact, all in clear, understandable language. This can give confidence to consumers who lack technical knowledge, making them feel more capable and in control of their energy use.

AI is not only making electricity smarter, but it helps users move from passive consumers to active protagonists with more control, convenience, and confidence.

[2] https://www.acer.europa.eu/monitoring/MMR/barriers-demand-response-2025/

INTEROPERABILITY

Interoperability has become a cornerstone of modern grid digitalisation, enabling seamless communication and data exchange between diverse systems, devices, and platforms across the power distribution network. The implementation of standardised protocols and data models, such as IEC 61850, CIM (Common Information Model), Open ADR, and other standards, ensures consistent interpretation and exchange of information between different vendors' equipment and software solutions.

This standardisation is particularly crucial as DSOs integrate an increasing variety of smart grid technologies, DERs, and third-party systems into their operations. By adopting interoperable solutions, utilities can avoid vendor lock-in, reduce integration costs, and future-proof their investments while maintaining operational flexibility.

Furthermore, interoperability facilitates the creation of a more resilient and adaptive grid ecosystem, where real-time data sharing between SCADA, ADMS, AMI, and other operational systems enables more efficient grid management and faster response to changing network conditions. This technological harmony is essential for achieving the full potential of grid digitalisation and supporting the energy transition towards a more distributed and renewable-based power system.

IoT AND SMART SENSORS

The deployment of IoT devices and smart sensors across distribution networks significantly enhances grid visibility and situational awareness. These technologies provide DSOs with real-time data on key parameters such as voltage, current, temperature and load, enabling faster detection of faults, localised issues, or abnormal conditions.

By continuously monitoring asset health and environmental factors, IoT-enabled sensors support predictive maintenance strategies, reducing unplanned outages and optimising resource allocation. They also play a critical role in improving grid reliability, supporting automation systems, and enabling more responsive, data-driven network operations.

DATA MANAGEMENT

For DSOs, effective data management is pivotal for overcoming digital challenges and unlocking new opportunities in the energy transition. A key focus lies in developing interoperable data architectures, i.e. systems that can seamlessly communicate, integrate, and exchange information across diverse platforms and stakeholders. By adopting standardised data models and open interfaces, DSOs can ensure that digital solutions, from smart grid applications to advanced forecasting tools, operate cohesively. This interoperability not only enhances operational efficiency and real-time decision-making but also enables greater collaboration with third-party service providers, prosumers, and regulators. Ultimately, it paves the way for more resilient, flexible, and consumer-centric energy systems, turning data into a strategic asset that drives innovation and sustainability.

Strategic Recommendations for DSOs

Roadmap for Digitalisation

A step-by-step action plan should be outlined for DSOs, tailored to their size, grid maturity, and level of digital readiness. To ensure grid reliability, efficiency, and resilience, DSOs must adopt a structured yet flexible approach to digitalisation that can adapt to their specific operational contexts and evolving challenges.

Assess the Current State

Understanding where the grid stands in terms of digital capability. A comprehensive assessment of the grid's digital maturity is a prerequisite for any effective smart grid strategy. This involves evaluating not only the technological infrastructure in place, but also how digital tools support the DSO's core functions—planning, operating, and maintaining the distribution network, where also the Smart Grid Indicators (SGIs) can provide a framework to assess the current capabilities.

Define Priorities

Following the digital maturity assessment, DSOs must identify and prioritise areas where digitalisation will yield the highest impact. Typical focus areas include grid automation (e.g. fault detection, isolation and recovery and voltage control) data management (integration, governance, quality), and the development of a unified ADMS platform. Prioritisation should be aligned with strategic goals such as resilience, flexibility, DER integration, and customer-centric services, as well as guided by SGI and regulatory benchmarks.

Pilot Projects

Before full-scale deployment, DSOs should implement targeted pilot projects that test the feasibility and value of digital solutions under real-world conditions. These pilots—ranging from local automation schemes to AI-driven load forecasting or sensor-enabled asset monitoring—provide critical insights into technical performance, integration complexity, and organisational readiness. They also allow DSOs to evaluate interoperability across IT/OT systems and validate business cases for broader investment.

Scalability and Grid-Wide Implementation

Successful pilots should serve as blueprints for scalable implementation. This requires ensuring that solutions are modular, standards-based, and adaptable to diverse grid conditions. The use of a centralised ADMS enables cross-functional scalability, providing a unified view of the grid while supporting distributed intelligence where needed. DSOs must also ensure that data architectures are capable of supporting increased data volumes and analytics workloads as deployments scale.

Collaboration and Knowledge Sharing

Digitalisation is not a siloed effort. DSOs must foster structured collaboration with TSOs, technology providers, regulatory bodies, and customers. Joint projects and shared platforms can enhance interoperability, align investments, and avoid duplication of effort. Moreover, coordinated data sharing—particularly across TSO-DSO interfaces—is critical for real-time coordination and whole-system optimisation. Participation in national and EU-wide innovation programmes (e.g. Horizon Europe, BRIDGE initiative) further accelerates learning and supports harmonisation across the sector.

Organisational and Technical Enablers of Smart Grid Development

Developing efficient and future-ready grid solutions requires interdisciplinary collaboration across DSO departments. To transition newly developed solutions from the R&D stage to a widely adopted tool in daily business operations, a structured change management process is essential to gain employee buy-in.

A 100% technology rollout is not always the most efficient method in terms of observability and controllability of technological deployment in grids. We recommend a targeted rather than universal approach to technology deployment, and a continuous reassessment of observability and controllability needs as the grid evolves.

Regulatory Support

Highlighting the need for supportive EU-wide policies that promote digital innovation, grid flexibility and grid investments.

Funding and Investment Opportunities

Provide guidance and improve access for small and medium-sized DSOs on leveraging EU funding mechanisms, including Horizon Europe, the Connecting Europe Facility, and national funds, for digital infrastructure projects.

Annex

Showcasing Best Practices from local DSOs

Workforce and Field Management: Estabanell y Pahisa Energía, S.A. Digitalisation Strategy

anĕll

Estabanell y Pahisa Energía, S.A. - Anĕll (ES) implemented a structured digitalisation framework focused on streamlining internal processes, enabling faster and better-informed decision-making, and breaking down departmental silos through advanced data analytics tools.

Background & Objectives

The key challenge anĕll aimed to address was inefficiency in internal workflows and limited interdepartmental collaboration. With growing complexity and data volume, the company recognised the necessity for modernising decision-making processes and enhancing cross-departmental cooperation through digital integration.

Implementation Approach

- A specific structured framework was developed to guide the digitalisation initiative.
- Initial steps included researching existing best practices combined with custom internal development tailored to the company's specific needs.
- Funding was secured through a mix of internal investments and operational expenditures.

Impact & Key Outcomes

- **Faster and Informed Decision-Making:** Integration of data and analytics empowered leadership teams, significantly reducing the time required for making critical business decisions.
- **Enhanced Collaboration:** The initiative effectively dismantled operational silos, substantially improving internal communication and cooperation.
- The implemented systems demonstrated robust integration and functionality between departments with more data exchange.

Lessons Learned & Future Steps

Understanding all existing processes comprehensively before launching digital initiatives was critical. Cross-departmental collaboration significantly contributed to successful implementation. Moving forward, anĕll plans additional projects to further optimise and integrate digital solutions across the organisation.

Annex

Streamlining internal processes: Wiener Netze's Journey from analogues to intelligent secondary substations

WIENER NETZE

Wiener Netze (WN, AT) is advancing the digitalisation of secondary substations in order to increase the observability and controllability of the medium and low voltage grid. This requires a clear blueprint for newly installed secondary substations, as well as a practical concept for upgrading existing analogue ones with minimal effort.

Background & Objectives

The status quo is that secondary substations are equipped with analogue short-circuit indicators (MV) and analogue Schleppzeiger (drag/trailing pointers) for measuring the peak load of transformers on LV without remote-control options.

To address current and future challenges, such as integrating a growing number of renewable energy sources (RES) and distributed energy resources (DER), and unlocking flexibility, it is essential to enhance observability in the LV grid through the targeted and systematic digitalisation of secondary substations. Close to real time data in combination with aggregated historical smart meter data (1/4h measurements) will provide adequate information about the utilisation of transformers and low voltage feeders.

In addition, the deployment of smart-grid-ready medium-voltage (MV) switchgear -featuring remotely readable short-circuit indicators, remotely controllable circuit breakers, and integrated measurements of MV feeders (including voltage, current, and active/reactive power) - is essential to enhance both observability and controllability in the MV grid.

- WN developed, tested and analysed different technologies and solutions to reach the required observability and controllability level.
- Based on cost-benefit analyses (min effort / max benefit), the best-fitting technologies were chosen to equip newly installed and upgrade existing transformer stations.
- WN developed a digitalisation roadmap that included a timeline for the rollout and criteria for identifying the most critical substations from a grid operation perspective. Depending on the specific objective, the approach distinguishes between a full (100%) rollout and an appropriate level of sensor implementation.

Impact & Key Outcomes

- Operational Efficiency:
  - Faster recovery after outages;
  - Voltage drops, phase imbalances or reverse power flows can be identified and addressed;
  - Observability is a precondition for the management of flexible loads and generators.
- In grid planning the available grid hosting capacity can be exploited (access to historical data will improve the accuracy of grid models).
- We anticipate significant efficiency gains in both the utilisation of our equipment and the processing times of customer inquiries.

Lessons Learned & Future Steps

- DSOs possess a wealth of distributed expertise across departments. Bringing together interdisciplinary teams—with knowledge in grid planning, operations, metering, ICT, and more—is essential for developing optimal and efficient solutions.
- Achieving sufficient observability and controllability does not require 100% technology deployment across all grid assets. A targeted approach, based on operational priorities, is more effective.
- The necessary level of observability and controllability is dynamic. It will evolve over time and requires a continuous process of assessment and adaptation to meet changing needs.

Annex

Unlocking the value of distributed flexibility through digitalisation: Giltre Nett's flexibility platform (Nodes)

Glitre Nett

Since 2016, Glitre Nett (NO), together with its mother company Å Energi, has worked on developing a market design and technology platform to unlock the value of distributed flexibility within the electricity network.

Background & Objectives

The aim is to implement a system for DSOs in which flexibility needs are detected and procured through a digitalised, market-based process.

With the advancement of the green transition, the need to optimise the utilisation of the existing electricity grid has become increasingly urgent. Concrete congestion issues in the 22, 132 kV grid have driven the exploration of whether distributed flexibility can be aggregated and effectively deployed to manage such challenges.

As a vertically integrated energy company, the organisation was able to engage comprehensively across all dimensions of the flexibility market, including the demand side, the supply side, and the market design, providing a unique opportunity to test and develop viable, scalable solutions for system optimisation.

Implementation Approach

Through several R&D projects, DER has been implemented initially via a DERMS solution, followed by the introduction of a flexibility market.

The first flexibility pilot was launched at the Engene substation in 2016, where Glitre Nett deployed a DERMS system. Local flexibility was managed under a single transformer (132/22 kV), with real-time monitoring and control used to prevent transformer overload during peak demand periods.

From 2019 to 2022, Glitre Nett participated in NorFlex, a large-scale demonstration project involving DSOs and the TSO. As part of this project, the Nodes local flexibility market platform was developed and put into operation. It successfully demonstrated how DER could be aggregated, traded on the market, and procured by system operators. In parallel, the "GridTools" platform was created to support flexibility assessment and optimisation.

The ongoing EuroFlex project (2024–2026) continues this development, focusing on using DER as a key tool for addressing grid congestion and enhancing grid utilisation. In this initiative, eight DSOs, collectively covering two-thirds of Norway's population, are collaborating to transition market-based flexibility from R&D pilots to standard operational practice.

Impact & Key Outcomes

- A digital flexibility value chain was established, facilitating new business models;
- A market model was successfully verified, incorporating industrial, commercial, and residential assets;
- Value stacking was demonstrated as aggregated flexibility was transferred from the Nodes platform to the TSO balancing market;
- The Nodes platform for leveraging flexibility for system operators was developed;
- The GridTools platform was developed as a decision-support tool for DSOs, with integration into the Nodes market platform.

Lessons Learned & Future Steps

- Start small and scale gradually. Pilot projects should precede full-scale deployment;
- Incentivise customer participation. Economic rewards are essential to drive engagement;
- Develop systems for automated flexibility bidding and dispatch;

Annex

GlitreNett

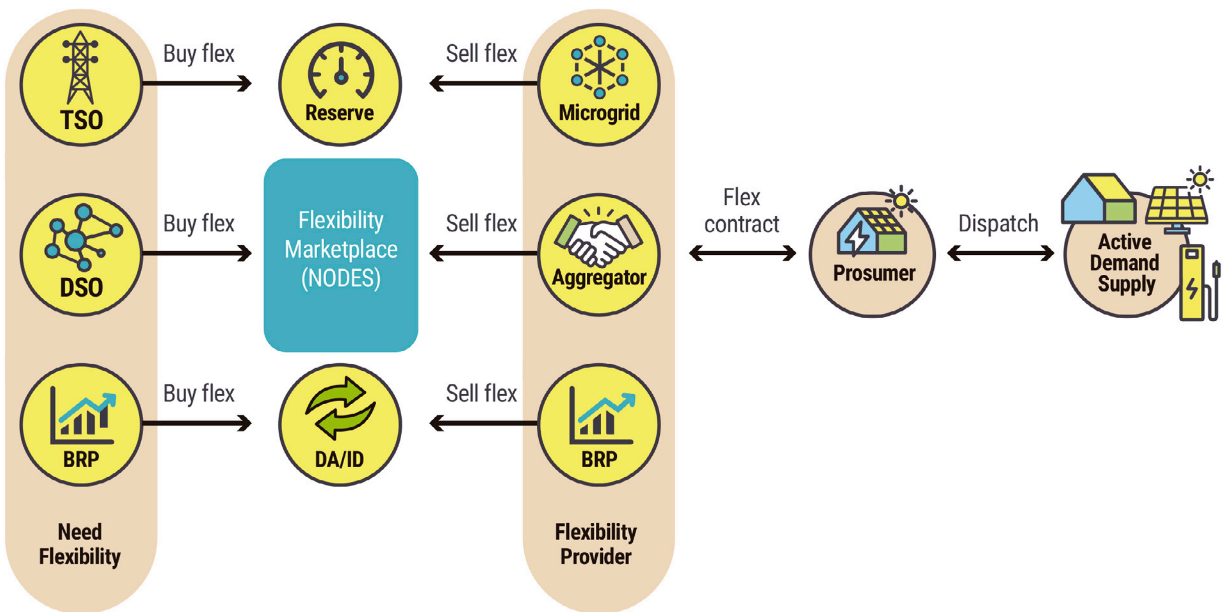
- Foster strong cooperation between DSOs and TSOs;
- Ensure regulatory frameworks support market-based flexibility solutions;
- Diversify market mechanisms. A mix of seasonal, weekly, and short-term products creates a more resilient system;
- Endurance and persistence are key.

The project will continue for an additional two years. Key challenges ahead include stimulating activity in a still-volatile market and addressing regulatory barriers, particularly the CAPEX-focused incentives that currently limit flexibility market adoption. Greater alignment between DSOs and the TSO will also be essential for the successful scale-up of market-based flexibility solutions.

Engene substation pilot

Norflex project

Market Design Norway (EuroFlex)



Annex

Improving Customer Experience: Helen Electricity's capacity planning and visualisation tool

HELEN

Helen Electricity Network (FI) initiated a strategic, customer-centric digitalisation project focused on enhancing customer interaction and experience through a data-driven, real-time capacity planning and visualisation tool. This solution streamlined communication, improved operational efficiency and facilitated customer decision-making processes.

Background & Objectives

Helen set out to address several core challenges, including prolonged response times, a growing volume of customer service inquiries, and limited visibility into customers' network capacity. The company aims to position itself as a leader in customer experience within the network industry by delivering seamless, data-driven, and fully digital services.

Implementation Approach

Helen adopted a strategic, customer-centric approach specifically designed to address the identified challenges. To ensure the solution aligned with real user needs, customer research was conducted, including remote prototype testing using Figma with representatives from housing associations. Feedback gathered during this process played a key role in refining the UI/UX design, ensuring the digital solution was both intuitive and relevant to user expectations. The initiative also involved close collaboration with external partners and consultants, complementing internal expertise with technical knowledge and innovative perspectives.

Impact & Key Outcomes

- **Operational Efficiency:** Customer inquiries were significantly reduced due to improved access to essential information, allowing internal resources to be redirected towards more productive and value-adding tasks.
- **Improved Customer Experience:** Customers benefited from 24/7 visual and real-time insights into available capacity, along with a dedicated tool to assess the appropriate size for electric vehicle charging stations. This simplified their energy-related decision-making processes and enhanced overall satisfaction.
- **Enhanced Communication:** Property managers effectively used the tool to clearly illustrate project possibilities to decision-makers, fostering better understanding and alignment among stakeholders.

Lessons Learned & Future Steps

Customer interviews provided valuable insights, underlining the importance of involving end-users early in the design process to improve the usability and relevance of digital services. Looking ahead, future initiatives will focus on expanding the digital service portfolio, including the development of new tools such as a solar panel sizing assistant.

Annex

Cuerva's grid digital asset and connection request automation

Cuerva*

Cuerva Energía, S.L.(ES), in its comprehensive DSO digitalisation journey, has implemented Adaion technology as a cornerstone of its grid modernisation strategy. This innovative solution represents a significant step forward in automating and optimising grid access and connection request management. By developing a complete digital twin of its distribution network, Cuerva has transformed traditional manual processes into an efficient, automated system that enhances both operational performance and customer service delivery.

Background & Objectives

Cuerva faced increasing challenges in managing grid connection requests efficiently. With the rapid growth of renewable energy installations and new consumption points, paired with new Spanish regulatory requirements, the traditional manual process for evaluating grid access and connection requests became a bottleneck. The main objectives were to:

- Streamline the connection request evaluation process;
- Reduce response times for customers;
- Improve accuracy in technical assessments;
- Optimise grid capacity utilisation;
- Ensure regulatory compliance.

Implementation Approach

Cuerva adopted Adaion technology, a digital solution that creates a comprehensive digital twin of the distribution network. The implementation process included:

- **Digital Asset Development:**
  - Creation of a detailed digital model of the grid infrastructure;
  - Integration of real-time operational data, from different systems (SCADA, GIS, etc.) and sensors (Smart-meters, switches, etc.);
  - Integrating real data with the grid model in order to build the digital twin.
- **Process Automation:**
  - Development of standardised evaluation protocols;
  - Integration with existing management systems (CRM, ERP, Customer Portal, etc.);
  - Implementation of automated validation checks.
- **Staff Training and Change Management:**
  - Technical training for engineering teams;
  - Process adaptation and workflow redesign;
  - Establishment of new operational procedures.

Impact & Key Outcomes

The implementation of Adaion technology has delivered significant benefits including operational efficiency, customer experience and business benefits.

Regarding operational efficiency, Cuerva achieved an 80% reduction in processing time for connection queues, increased the accuracy of technical evaluations and enhanced grid capacity optimisation, maximising use.

Customers were able to access faster response times to connection requests, from several weeks to only a few days. In addition, evaluation processes were made more transparent and technical assessments' consistency was significantly improved.

Finally, Cuerva was able to reduce operation costs, while enhancing regulatory compliance. In order to comply with the current Spanish regulatory framework, processes were adapted to calculate new connection request demands and generation accurately. In addition, decision-making capabilities were improved through recommendations based on current and future projections of grid health.

Annex

Cuerva*

Lessons Learned & Future Steps

The success of digital transformation initiatives hinges on robust change management practices. Ensuring high data quality, along with routine system updates and maintenance, is essential to maintaining operational efficiency and effectiveness.

Equally important are comprehensive staff training programmes and active employee engagement, which are critical enablers for sustainable implementation and adoption of new digital tools.

Looking ahead, Cuerva is exploring the integration of advanced analytics and artificial intelligence to further streamline internal processes. This includes the development of intelligent algorithms to support the calculation of non-firm connection agreements and to address evolving flexibility requirements.

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LIST OF ABBREVIATIONS

ACER	Agency for the Cooperation of Energy Regulators
ADMS	Advanced Distribution Management Systems
AI	Artificial Intelligence
AMI	Automated Metering Infrastructure
AT	Austria
CAPEX	Capital Expenditure
CBM	Condition-based Maintenance
CIM	Common Information Model
CRA	Cyber Resilience Act
CRM	Customer Relations Management
DER	Distributed Energy Resources
DERMS	Distributed Energy Resource Management System
DSO	Distribution System Operator
EMS	Energy Management Systems
ERP	Enterprise Resource Planning
ES	Spain
EU	European Union
EV	Electric Vehicle
FI	Finland
GDPR	General Data Protection Regulation
HR	Human Resources
ICT	Information and Communication Technology
IOT	Internet of Things
ISMS	TInformation Security Management System
IT	Information Technology
LV	Low voltage
MV	Medium Voltage
NCCS	Network Code on Cybersecurity
NO	Norway
R&D	Research and Development
RES	Renewable Energy Sources
SCADA	System control and data acquisition
SGI	Smart Grid Indicators
TSO	Transmission System Operator
V2G	Vehicle to Grid
VR	Virtual reality
WN	Wiener Netze

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