Grid management systems – Digitalisation Journey for Distributors

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1. Introduction

New technology has been revolutionising and disrupting industries all over the world and now the world is on the verge of a new dawn for the electricity industry. Current power stations and electrical infrastructure were built many years ago and as such, they need modernizing if they are to keep pace with the technology driven world today.

Digitalization of power distribution is a broad journey, which is made up of different components and requires funding. All digitalisation journeys end up in data analytics, which enables the distributors to be able to make decisions faster and act on them, resulting in a reliable and resilient electricity supply, meeting customers' needs and having a sustainable business

In general, the existing systems and equipment in place need to be improved/enhanced or replaced together with the communication infrastructure to pave way for digital transformation of distributors. This paper describes how taking a phased approach to achieving digital transformation can help overcome the technical challenges, allowing distribution utilities to improve operations and achieve significant organizational benefits.

2. Drivers of digitalisation

According to a World Economic Forum article, three trends in particular are converging to produce game-changing disruptions in the electricity distribution industry (Astarios et al, 2017):

- Electrification/Decarbonisation of large sectors of the economy such as transport and heating.
- Decentralization, stimulated by the sharp decrease in costs of distributed energy resources (DERs) like distributed storage, distributed generation, demand flexibility and energy efficiency.
- Digitalization of both the grid, with smart metering, smart sensors, automation and other digital network technologies, and beyond the meter, with the advent of the Internet of Things (IoT) and a surge of power-consuming connected devices.

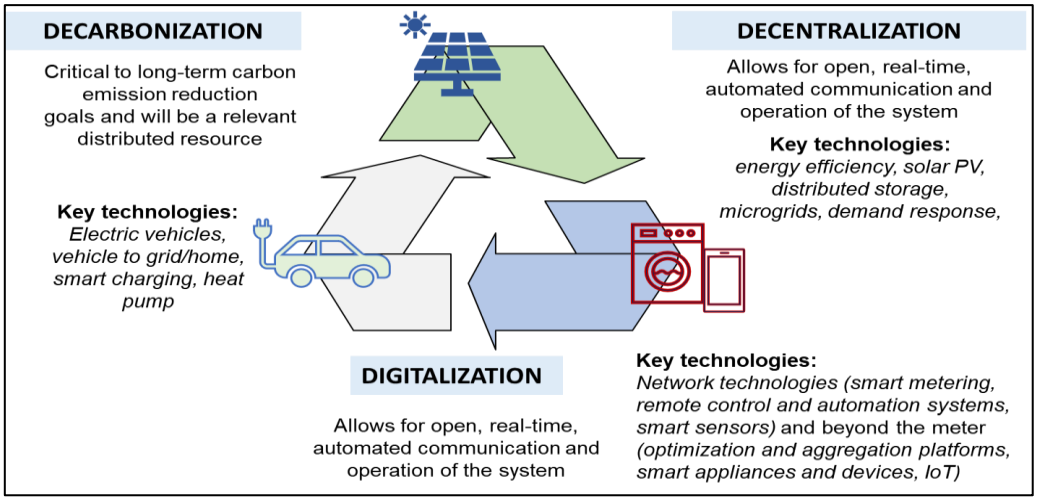

Figure 1: Grid edge transformation trends (Astarios et al, 2017)

In Sub-Saharan Africa (SSA), Frost& Sullivan (2018) identified four game changers have emerged that will have the biggest impact on the digital grid roadmap in the region: Renewable energy; energy storage; smart metering; and distributed energy. These trends will converge to transform energy management in SSA against the backdrop of low electrification rates, rising energy demand, increasing urbanization, an overriding need for security of power supply, and cross-border electricity trade. Combined with a decreasing price of renewable energy technology, increasing connectivity and ongoing innovations in energy technology, the region is poised for an exceptionally exciting decade of transformation and opportunity.

In addition, an accelerating pace of innovation led by key technology advancements is laying the foundation for the digital transformation of the power industry. Transformations in the way electricity is produced, stored, managed, and consumed calls for grid operations to be adapted to perform in a flexible energy environment. Other technical challenges such as proprietary legacy systems, converging of information and operational technologies (IT/OT), aging infrastructure, cyber-attacks, regulatory bottlenecks and growing threat of energy capacity constrains experienced in the country forces distribution grid owners and operators to embrace digital transformation solutions.

Digital platforms are disrupting the distribution landscape, changing how customers discover and purchase products. This significantly impacts supply chains as businesses race to keep up with customer demand. To stay competitive, businesses need to understand the importance of digital transformation in distribution the confluence of favourable technological advancements and market developments have influenced utilities/distributors such that they can now transform their business processes by an end-to-end sharing of information across the entire business, improving operations and effectiveness of customer delivery.

3. Current challenges

Frost & Sullivan (2018) contends that conventional grids are typically characterized by partial control, poor technology integration and optimization, reactive maintenance, and fragility of systems. In addition, South African utilities have challenges with ageing infrastructure, growth in electricity demand and challenges of integrating an increasingly diverse mix of energy sources. A Legacy grids and conventional technologies will tend to hinder the efficiency that can be achieved in the following ways (Frost & Sullivan, 2018):

- Limited input/outputs which limit access to data to support decision making.
- Limited real-time visibility over the network.
- Limited control over the network.
- Vulnerability to inaccuracies.
- Integration of new energy sources or new equipment causes downtime due to the complex hard wiring required to ensure compatibility.
- Single flow of electricity so generation surpluses are not effectively leveraged.
- High cost of repairing or replacing large, aged equipment required in an analogue system.
- Loss of revenues resulting from inaccuracies in meter readings

The utilities in south Africa are still experiencing challenges of monitoring and controlling the network and mostly in analysing the data received from the equipment, in order to make informed decisions for the distributors at any given time. As a result of capacity constraint, customer faults and other network interruptions, it is important for the grid systems to be smarter and live 24/7

4. Benefits of digitalisation

The digitalization of the power sector allows for greater transparency into operations, which greatly increases efficiency, enables better energy management and reliability while decreasing costs. Consumers will not only see the benefits of digitalization through lower monthly utility bills but also reduced outages and faster response times, better demand, supply/demand response and better power quality. Renewables integration and carbon emissions reduction will also be realised in the journey to digitalization. For utilities, data is the backbone of their digitalization journey. This data can come from utilities' assets, systems, and operations as well as external sources like weather forecasts. With the right software that crosses business wide data and system data storage, utilities can have a single source of truth that enables collaboration and optimizes operations. The systems enable the operators and users to effectively respond to real time information by providing situational awareness and perform varieties of real time analysis and studies. These integrated systems are being shaped by digital tools that enable data-driven decision making across the organization and allow a range of technologies to coexist.

There are many benefits associated with digitisation that run across all stakeholders including customers and the utility itself. Some of the benefits are covered below

Asset Management

There are extensive opportunities to increase the effectiveness and reduce the cost of asset management. These include the following:

- Near real time monitoring of asset condition with remote, connected sensors.
- Use of robots of various types (including drones) for asset inspections. This includes remote control and / or AI driven autonomous operations.
- Use of data analytics and AI to interpret asset condition data.
- Use of real time monitoring and robotics to improve asset security, preventing or responding effectively to theft and damage.

Grid Operation

There are opportunities, to better monitor, automate and optimise grid operations:

- Automation of grid operations, such as self-healing grids.
- Reduction of operations costs by increased remote control and / or autonomous operations.
- Automation of operations to maintain and less dispatch able renewable generation increases.
- Real time monitoring of the operating state of the grid and using this to better optimize operations.
- Early detection, diagnosis and correction of faults.

- Increased verification of operating and maintenance activities.

Customer Operations

There are opportunities to improve customer service and customer operations, re-wiring of customer operations is needed to become more customer centric:

- Demand management capabilities, better balancing supply and demand when capacity is constrained, and offering customers more options.
- Customer interaction channel served by a chat bot - already a basic one in place, but much work still needed to enhance its operations.
- Automation of data collection from customer interactions, e.g. identifying / verifying which feeder a customer is on when a fault is logged.
- More effective proactive customer notifications.
- Automation of customer interactions and product operations.

Business management and execution

There are opportunities to improve general business execution functions:

- Use of AI for forensic insights and response
- Nerve centre and response supporting real time decision making.
- Supply chain optimization and security

Digitalization of the grid will benefit the distributors in reducing energy losses, smart grid systems must also address both technical and non-technical losses. To reduce technical loss due to natural power dissipation, software that processes voltage, current, real and reactive power, and phase can make real-time adjustments. To address non-technical loss, data from smart meters, intelligent devices, and distribution grid sensors can identify where there may be theft or other power loss.

5. Digitalisation of the grid

5.1 Grid Modernisation

To achieve digital maturity, utilities must pass through stages of progression such as digitization, digitalization and enterprise integration before they can effectively meet evolving regulatory and business challenges. In general, the existing systems and equipment in place need to be improved/enhanced or replaced together with the communication infrastructure to pave way for digital transformation of distributors in achieving a smart grid. The systems enable the operators and users to effectively respond to real time information by providing situational awareness and perform varieties of real time analysis and studies. These integrated systems are being shaped by digital tools that enable data-driven decision making across the organization and allow a range of technologies to coexist.

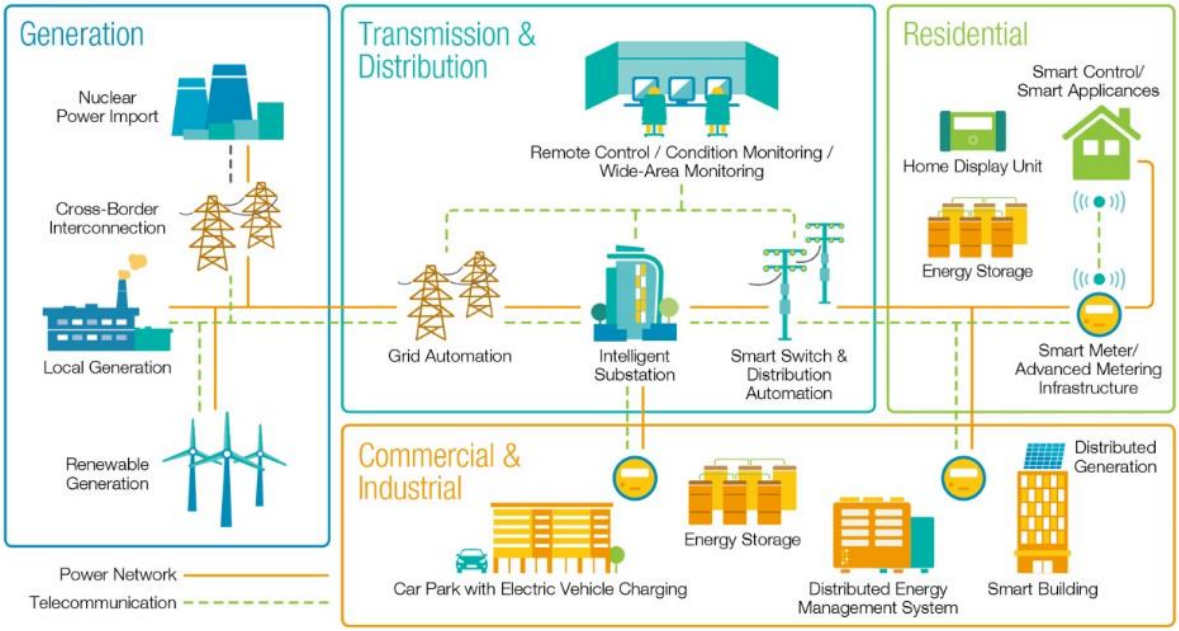

Figure 2: Overview of Smart Grid Technology (Elprocus, 2023)

Moving from a legacy analogue system to a modern, digitalised energy system, is a critical step in enabling the South African transition to net zero carbon emissions while keeping the lights on for customers. The availability and utilisation of good quality and accessible data is key. This means providing increased access to the right data at the right time within our organisation and through open access to our customers and interested stakeholders. Digitalization and distribution utilities along its digitalization journey, enables data from sensors to be used to enhance decision-making throughout the utility. the main goal of a utility is to achieve an increased visibility of their physical assets, which in turn enables the migration from asset focus to system-level analysis. Device-level sensing & data acquisition data communications fleet level analytics & remote management system-wide data integration asset visibility.

The five main drivers of grid modernization

- **Reliability and Resiliency**
  Proactively manage people and field assets to minimise the frequency and duration of outages

- **Efficiency**
  Provide visibility into the real-time conditions of network to optimise power flow

- **Sustainability**
  In corporate renewable and distributed energy resources into the grid. Strengthening of the network to accommodate upcoming IPPS and SSEG's.

- **Operational effectiveness**
  Proper awareness and conditions of assets through information technology

- **Customer engagement**
  Provide grid management awareness through hardware and software solutions e.g.: Eskom has Alfred chatbot….

5.2 Digitalization Journey

Hitachi (2022), states that moving from a legacy analogue system to a modern, digitalised energy system, is a critical step in enabling the South African transition to net zero carbon emissions while keeping the lights on for customers. The availability and utilisation of good quality and accessible data is key. This means providing increased access to the right data at the right time within the

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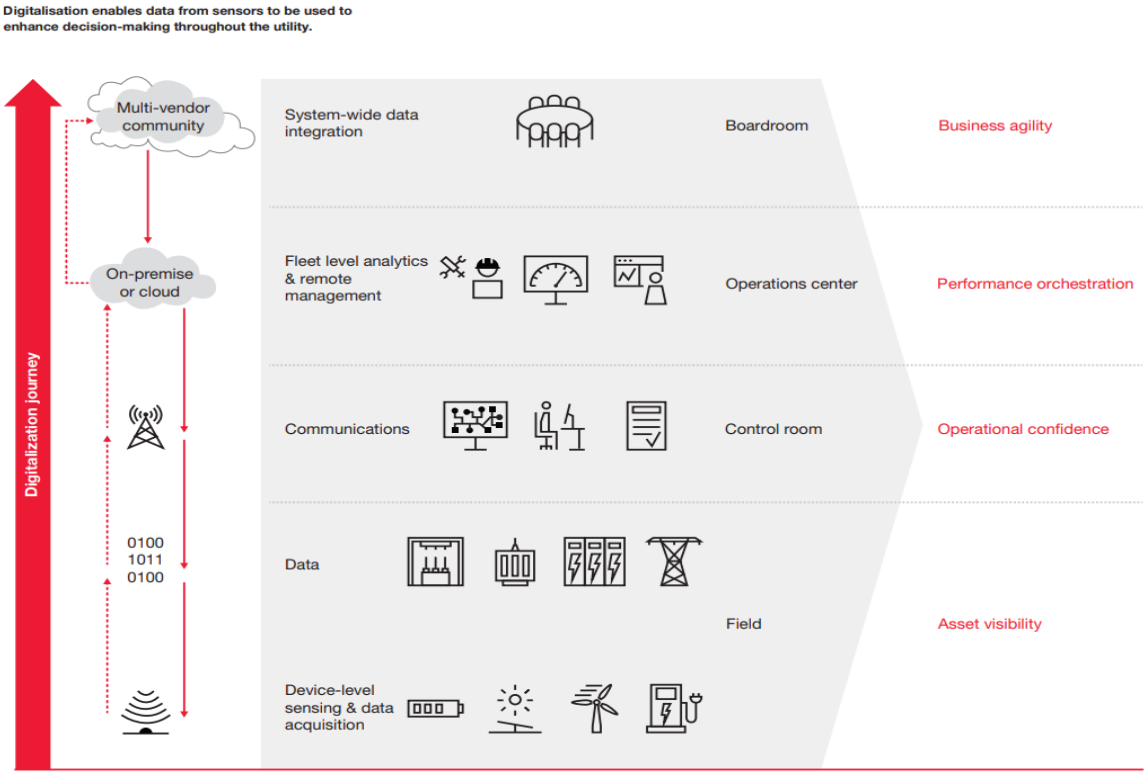

Figure 3: Digitalization journey (Hitachi, 2022)

Utilities in general follow the following six steps to begin their digital transformation journey:

- Determine what "Digital" means to your company
- Establish how your company will go digital
- Make executive buy-in a priority
- Find partners to accompany you on the Digital Transformation Journey
- Prepare your workforce for the Digital Transformation
- Begin the Digital Transformation

Power producers and utilities are embarking on a journey to digitize their processes. This will require not just investment in new technologies, but also a shift in mindset and business models—and the shift will need to be faster than ever before. Digital innovations rely on openness and collaboration to realize their full value. Therefore, power producers and utilities will need to break down barriers separating their organizational silos. To do so, their CEOs, CIOs and COOs need to select the right technology partners that can help them bridge the IT and OT domain expertise. Internal and external collaboration will be mutually reinforcing. As this new wave of innovations brings together very different areas of expertise at an accelerated pace, partnerships are essential to succeed. This transformation will need high coordination among stakeholders. Energy providers will join a new breed of digital-industrial companies, by investing in new technologies and finding new ways to provide tailored solutions to customers. It will need development of open standards and interoperability between products, the nurturing of a new generation of personnel, and the highest level of cyber security.

5.3 Digital Maturity

When the journey is completed, the utility is said to have reached digital maturity. Most utilities in South Africa are on the first two strategies of digital maturity. The three digital maturity stages for the distribution utility are as follows:

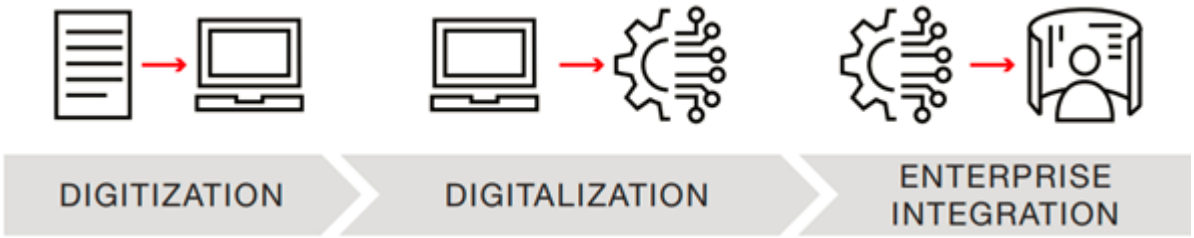

Figure 4: Digital maturity stages (Hitachi, 2022)

- **Digitization**

Digitization refers to the process of converting analog data into digital formats that can be gathered, stored and processed by a computer. In the energy sector, the data not only becomes more accessible and moves faster but can also work synergistically to provide optimal plant and grid output.

- **Digitalization**

A utility may be considered “digitalized” when data can be captured and communicated autonomously throughout a distributed network. Once digitalized, business velocity can accelerate because systems are more efficient and responsive, which allows innovation to occur more rapidly.

- **Enterprise integration**

In this level, the optimization of strategic, data-driven decision-making and digital processes are applied to solve business challenges. Since the integrated analytics and optimized process and systems across the enterprise have been already established in stage 2, the utility will now have a holistic, 360-degree view of the customer that helps in improving delivery, digital communication and customer experience.

6. Conclusion

Energy market evolution is disrupting current utility revenue streams and business models consequently pushing digital transformation of energy utilities. Utilities in general (including Eskom) have typically been asset centric, as opposed to product centric. Key options for evolving utility business models include leveraging new business off existing asset base. Utilities have to re-examine their business models, to survive and thrive in the evolving industry. Digital transformation capabilities enable us to evolve our products, to improve their benefits to our customers and ourselves. The process of digitizing the grid will be a lengthier process in SSA than it has been in more developed regions. This can be attributed to the difficulty of securing financial capacity for such a transition. Inadequate finances have always posed a major barrier to infrastructure development in the energy sector.

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