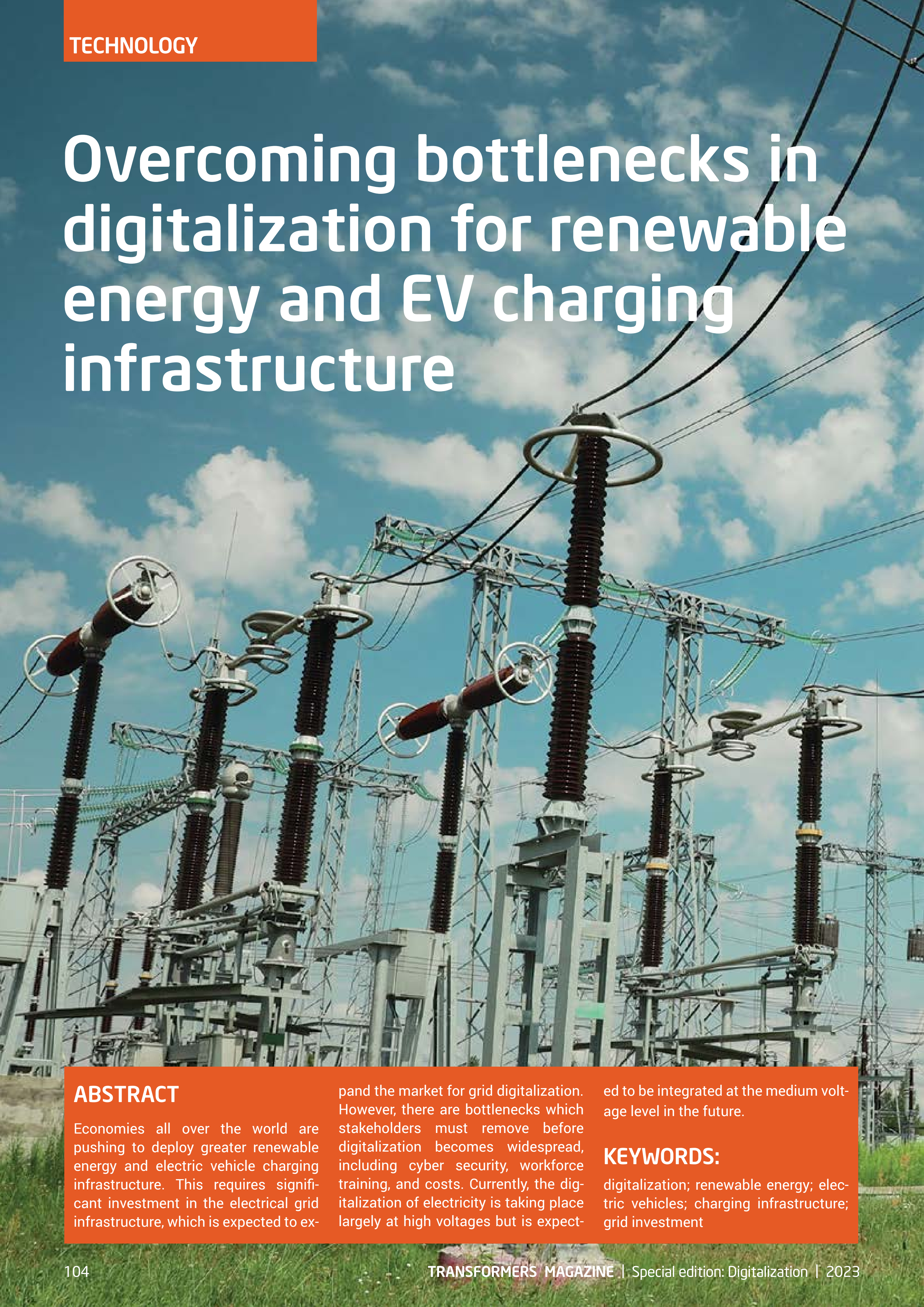

Overcoming bottlenecks in digitalization for renewable energy and EV charging infrastructure

ABSTRACT

Economies all over the world are pushing to deploy greater renewable energy and electric vehicle charging infrastructure. This requires significant investment in the electrical grid infrastructure, which is expected to expand the market for grid digitalization. However, there are bottlenecks which stakeholders must remove before digitalization becomes widespread, including cyber security, workforce training, and costs. Currently, the digitalization of electricity is taking place largely at high voltages but is expected to be integrated at the medium voltage level in the future.

KEYWORDS:

digitalization; renewable energy; electric vehicles; charging infrastructure; grid investment

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Economies across the globe, specifically advanced economies such as the US and EU member states, are rapidly deploying renewable generation and electric vehicles in order to combat climate change

According to forecasts by Power Technology Research (PTR Inc.), global renewable capacity is projected to increase by 60% for the five-year period 2018-2022 relative to 2023-2027

1. Introduction

Economies across the globe, specifically advanced economies such as the US and EU member states, are rapidly deploying renewable generation and electric vehicles in order to combat climate change. The Paris Agreement played a significant role in this regard. It is a legally binding international treaty on climate change that aims to curtail an increase in the global average temperature below 2 degrees Celsius relative to pre-industrial levels. The "stretch goal" is an increase of only 1.5 degrees Celsius [1]. Signatory countries have set ambitious targets in line with international commitments on climate change.

As countries push toward these targets, the demand for renewable energy generation and electric vehicles has grown over the years. In turn, this necessitates consideration of their impact on the power grid and how to manage it. Digitalization of the electricity grid has emerged as a solution which enables widespread integration of renewable generation and electric vehicle charging infrastructure in an efficient and reliable manner.

2. Developments in the market supportive of grid digitalization

Economies are pushing to decarbonize the power and transportation sectors in a bid to achieve net carbon neutrality over time. This is expected to drive significant growth in renewable generation capacity. In turn, more electric vehicles will increase the demand for charging infrastructure. The surge in deployment of renewable generation capacity and EV charging infrastructure is expected to spur digitalization.

2.1 Decarbonization

According to forecasts by Power Technology Research (PTR Inc.), global renewable capacity is projected to increase by 60% for the five-year period 2018-2022 relative to 2023-2027. In comparison, the global electric vehicle market is expected to grow with a Compound Annual Growth Rate (CAGR) of 20% from 2022 to 2030.

Notably, a global renewable generation capacity of approximately 1300GW was installed between 2018 and 2022. It is expected that 2000GW of renewable generation capacity will be installed globally between 2023 and 2027. As to utility-scale solar capacity, 390GW of generation capacity was installed between 2018 and 2022. In the future, 710GW of generation capacity will be installed from 2023 to 2027, according to PTR Inc.. On the other hand, additional wind power capacity between 2018 and 2022 accounted for 405GW. This includes onshore wind capacity of 355GW and offshore, 50GW. Going forward, PTR Inc. forecasts wind power capacity additions of 610GW from 2023 until 2027. This includes onshore wind of 490GW and offshore, 120GW.

Key economies across the globe have set ambitious targets for the deployment of renewable energy generation and EV chargers, including Germany, the UK, France, Italy, Spain, the Netherlands, Saudi Arabia, the United States, Canada, Australia, India, and China. Germany targets 80% of electricity generation from renewable energy sources by 2030, followed later by the goal of 100%. Germany also strives to install 1 million charging stations by 2030.

The UK aims to generate 100% of electricity from renewable energy sources by 2036 and install 300,000 chargers by 2035. France targets electricity generation from renewable energy sources at over 40% by 2030. France also aims to install 7 million EV chargers by 2030. Italy plans to increase the share of renewables to over 30% and install 30,000 EV chargers by 2030.

Moreover, Spain has an ambitious target of renewable energy generation to over 70% by 2030, followed by 100% generation from renewable energy sources by 2050. To cater to EVs in the Spanish market, it has set a target of 3 million chargers by 2030. The Netherlands plans to increase the share of renewable energy to over 70% by 2030, followed by 100% by 2050. To assist widespread deployment of EVs in the Netherlands, they plan to install 88,000 EV chargers by 2030.

The United States plans to generate 80% of electricity from renewable energy sources by 2030, followed by 100% by 2035. In order to pave the way for the widespread deployment of electric vehicles, the US aims to install 60,000 chargers by 2050 and 500,000 by 2030. Canada is pushing to increase the share of renewable energy sources to 90% by 2030. It also targets to install 5000 EV chargers by 2029. Australia is moving to increase the share of generation from renewables from 27% to 82% by 2060. They target to install 90,000 EV chargers by 2030. India is planning to install 500GW of renewable generation capacity by 2030, including 280GW of solar and 140GW of wind power.

Saudi Arabia aims to generate 50% of its electricity from renewable energy sources by 2030. China targets wind and solar capacity of 1200GW by 2030. State Grid targets to install 18,000 public chargers by 2025.

2.2 Grid modernization

Utilities across the globe are making significant investments in grid modernization with a focus on digitalization. A Distribution System Operator (DSO)

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in the UK, UK power Networks plans to invest USD 5.7 billion between 2023 and 2028. This includes USD 161 million allocated to the development and deployment of digital solutions [2]. A DSO in Spain, Endesa, plans to invest USD 13 billion from 2021 to 2030 on network digitalization and modernization, aiming to reduce network losses by 3% [3]. An electricity and gas DSO in Belgium, ORES is spending USD 810 million from 2021 to 2023 with a focus on energy flow measurement upgrades, remote electricity network reconfiguration, and fibre optics for telecommunications reinforcement [4]. HydroOne plans to spend USD 3.9 billion on grid modernization and digitalization in Canada [5]. Italian DSO ACEA plans to invest USD 1.275 billion from 2022 to 2024 in smart meters, new control centres, and digitalization through IoT and remote control [6]. At the same time, HEP - a Croatian national electric power company - plans to invest USD 1.17 billion from 2022 to 2031. HEP is digitalizing management systems in distribution control centres and distribution dispatch centres. This will be followed by the modernization of remote-control systems in power facilities [7]. To conclude, massive investments are being made globally to modernize electricity grids. This facilitates the integration of renewable energy and supports EV charging infrastructure, and will, in turn, drive the growth of the global digitalization market.

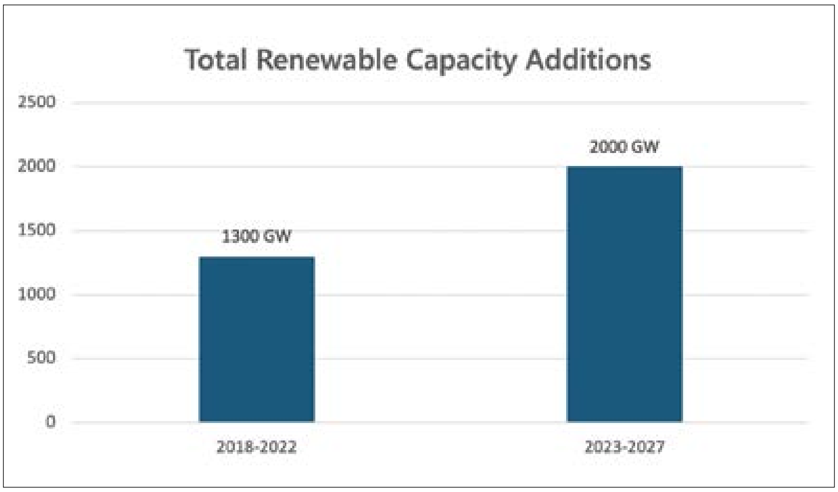

Figure 1. Total global renewable capacity additions.
Source: PTR Inc.

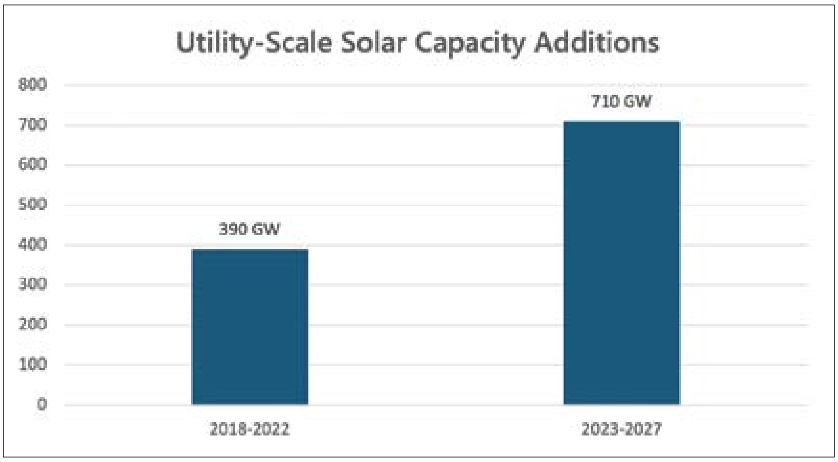

Figure 2. Total utility scale solar capacity additions.
Source: PTR Inc.

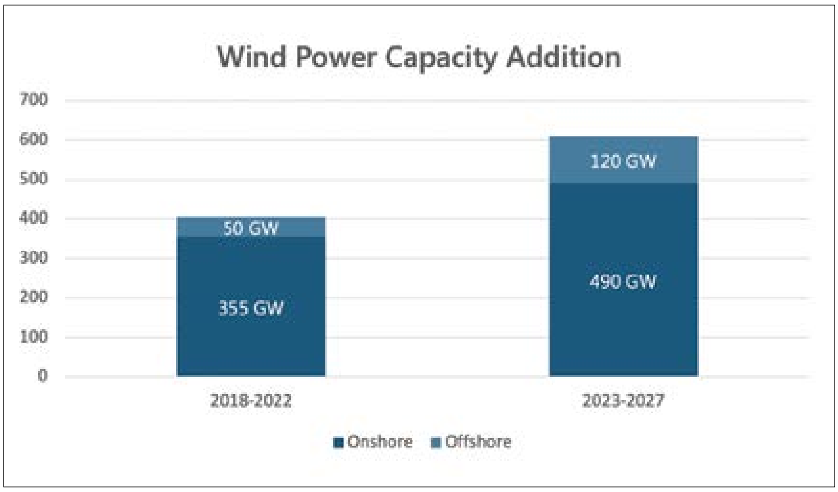

Figure 3. Total global wind power capacity additions.
Source: PTR Inc.

3. Challenges and barriers to growth

Besides investment challenges for grid modernization driven by decarbonization, the grid faces other challenges to digitalization. The market must cater to the challenges of cyber security, workforce training, and costs. Unless bottlenecks are removed, digital technologies will not be fully adopted in electricity grids.

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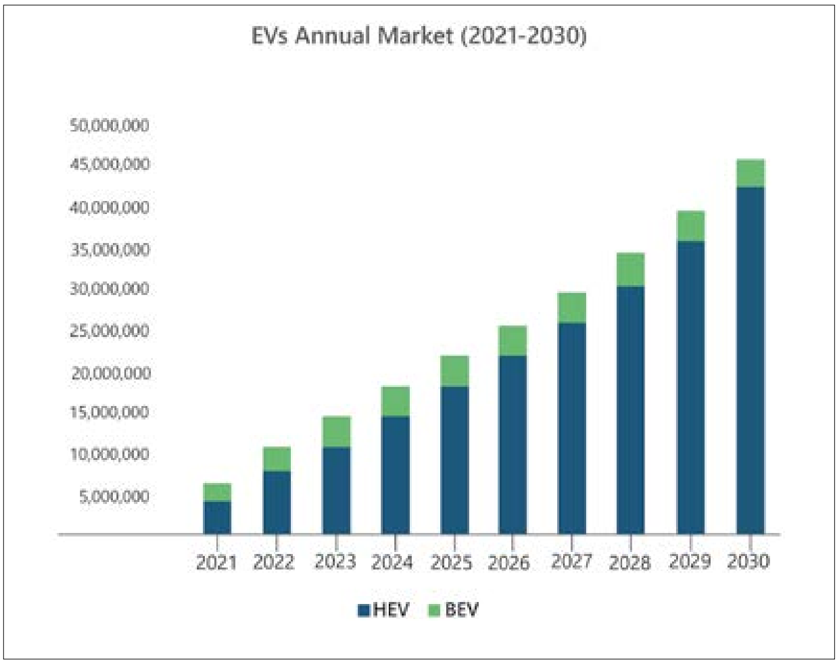

Figure 4. Global EV annual market (2021-2030).
Source: PTR Inc.

3.1 Cyber security

Cyber security is a serious concern for governments, utilities, and consumers: the data of millions of consumers could be leaked in a breach. The protection of electricity grid information is a national security concern. Cyber security must be prioritized and strengthened in order to avoid leakage.

Unless these concerns are addressed by stakeholders in the digitalization industry, market players will be reluctant to adopt the technology. In turn, this could hamper long-term climate goals. This holds true especially in the power sector, as digitalization is a key enabler for the deployment of renewable energy and the EV charging infrastructure.

3.2 Workforce training

Digital technologies are relatively new, especially for electricity grid equipment, and the utility workforce lacks training. Accordingly, initiatives should be taken to bring technician skill levels up to modern requirements.

3.3 Cost implications

The costs of integrating digital technologies into the electricity grid fall into three categories.

Simple advancement is achieved by installing sensors in grid equipment, for example, on conventional transformers.

Mid-level digital advancement is reached when both sensors and communication devices are installed on grid equipment.

This enables real-time monitoring.

High-level (and higher cost) digitalization entails the integration of sensors, communication devices, and data analysis software. As we move from low level to higher level digitalization, cost increases as well. It is critical for net cost to decrease in a manner that a business case can be made to integrate digital technologies with grid equipment.

4. Conclusion

Notably, digitalization is taking place mostly at high voltage. But it is expected to migrate to medium voltage levels. Recently, the Enel Infrastructure and Networks division opted to install the TXpert™ Ecosystem for the digitalization of transformers from ABB Power Grids. Installation of the TXpert™ Ecosystem not only improved the efficiency and reliability of transformers but also the connected grid [8]. The digital Ecosystem also helped optimize maintenance, in turn increasing equipment life.

Additionally, Hitachi ABB Power Grids has replaced a 50-year-old transformer with a TXpert™ enabled power transformer for Fortum [9]. The digitalized transformer is instrumented with temperature, pressure, oil condition, and voltage sensors to monitor and analyze its health, which improves performance and reliability. Similarly, in Chile, Hitachi ABB Power Grids' digital transformers are improving access to reliable and clean energy. It enabled major new wind and solar power projects in the country [10]. Mainstream Renewable Power's 1.3GW wind and solar platform Andes Renovables used digitally enabled transformers from Hitachi ABB Power Grids for the integration of sustainable electricity across nine of Mainstream's Chilean projects [10].

Market stakeholders must cooperate to remove bottlenecks such as cyber security concerns, workforce training, and costs to enable widespread digitalization. Cyber security will be a major concern for import-dependent markets (for power transformers) which have conflicts, like the United States. Workforce training will be required globally. As to digitalization cost, it will be a major concern for utilities in developing countries which have limited budgets.

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Azhar Fayyaz is a Market Analyst at Power Technology Research. He is involved in projects on power grid topics at Power Technology Research, gathering data on the network structure of distribution utilities, estimating the installed base of T&D equipment, and analyzing information to predict future market trends. As a market analyst at PTR Inc., he performs competitive analyses of companies operating in a region and determines their market share for a specific product. He also has more than 2 years of experience working as a senior shift engineer at Chashma Power Generation Station. Azhar comes from a technical background and has a M.Sc. in Power Engineering.