Technological change in the Electrical Equipment Industry

Development Dialogue

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Outline

- Overview of the industry
- Emerging technologies and drivers of technological change
- Technological changes
- Trends in South Africa
- Conclusions

Industry overview

- Products included in the industry
  - Insulated wire and cables (SIC 363)
  - Electric motors, generators and transformers (SIC 361)
  - Electricity distribution and control apparatus (SIC 362)
  - Accumulators, primary cells and primary batteries (SIC 364)
  - Electric lamps and lighting (SIC 365)

- Economics of the industry in 2024
  - Contributed 2% to manufacturing gross value added (GVA)
  - 4% to manufacturing employment
  - South Africa had a negative trade balance, approximately R58 billion

Emerging technologies

- Internet of Things (IoT)
  - Refers to a network of interconnected devices that collect, analyse, and transmit data through sensors, communication devices, and computers. Enables remote monitoring and predictive maintenance.
- Artificial Intelligence (AI)
  - Combines computer science and data from equipment and processes to mimic human intelligence in learning, decision-making, and problem-solving. Enhances operational and cost efficiency, advances innovation, improves quality.
- Digital Twins
  - A digital twin is a virtual representation of a physical object or process. It is generated using data collected from sensors connected to the physical world. Creates virtual models of equipment for simulation and testing.
- Augmented/Virtual Reality (AR/VR)
  - Creates a fully or partially immersive environment that allows users to interact with objects as if they were real. Improves training, accuracy, and safety.
- Additive Manufacturing (3D printing)
  - Additive manufacturing is a process of producing objects by adding material layer by layer, based on a digital design. Produces parts with less waste and lower emissions (as manufacturing can take place closer to customers).

Drivers of change

- Outside of advancements in digitalisation, efficiency and sustainability objectives are the main drivers of technological change.
  - Businesses and utilities are increasingly turning to digital solutions, that leverage data analytics and remote monitoring and control, to reduce downtime and optimise the performance of assets.
  - Rapid population growth – particularly in developing countries – has fueled the need for efficient, and sustainable infrastructure solutions.
  - Simultaneously, the need to upgrade existing electricity infrastructure in many regions has intensified, as traditional systems often fail to meet modern efficiency and environmental standards.
  - Similarly, global climate change commitments have led to a rise in the installation of renewable energy technology, which relies on advanced components for optimal integration into existing energy systems.
  - Finally, increased consumer awareness of environmental impacts and growing demand for smarter, greener technologies have prompted businesses and governments to respond.

TECHNOLOGICAL CHANGES IN THE ELECTRICAL EQUIPMENT INDUSTRY

- IoT for electric motors
  - IoT-enabled sensors gather and analyse data related to motor vibration, speed, and temperature to identify potential failures or malfunctions before they occur.
  - Facilitates remote control of electric motors, enabling remote adjustments to operational parameters.

- AI for the design of electric motors
  - AI algorithms can analyse extensive datasets of electrical components and design rules and produce optimised designs more efficiently than manual methods.
  - AI also enables virtual prototyping. Engineers can simulate electrical systems and test designs in a digital environment, eliminating the need for costly physical prototypes.

- Digital twin technology for electrical transformers
  - Can simulate temperature behaviour, overload capacities, and insulation ageing, with operators being able to access the information digitally.
  - It also provides visualisation tools to support decision-making when evaluating equipment.

TECHNOLOGICAL CHANGES IN THE ELECTRICAL EQUIPMENT INDUSTRY

- AR for electrical wiring
  - Using AR glasses, technicians view detailed, interactive 3D models of aircraft, for example, and its components overlaid on the real-world assembly line. This allows them to follow precise instructions, view wiring schematics, and ensure that parts are installed correctly.

- Additive manufacturing for lamps and lighting
  - Use fewer materials, can incorporate recyclable products, and results in fewer carbon emissions as products can be produced locally, reducing transportation emissions.
  - Fittings and fixtures can be customised depending on preferences.

- Emerging technologies applied in electrical utilities
  - Dubai Electricity and Water Authority

Trends in South Africa

- WEG Motor Scan solution
  - The motor scan allows for the monitoring of information related to radial and axial vibrations, motor temperature, and operating time.
  - Users can access and analyse the stored data directly on their mobile devices or explore it in greater detail on the WEG IoT platform.
  - Also supports the configuration of maintenance alerts.

- Hitachi Digital Twins
  - Hitachi Energy has a digital twin solution for high-voltage direct current systems and power quality applications.
  - Solution consolidates asset information analytics, and operational data into a user-friendly, customisable dashboard
  - Features interactive 3D visualisations of assets and offers access to related plant and equipment details.

Trends in South Africa

- BEKA Schréder Augmented Reality
  - Digital application that allows users to interact with their products remotely.
  - Enables users to visualise BEKA Schréder's products and poles in real-world environments, both indoors and outdoors, using augmented reality. Users can toggle product lighting to compare optics and photometry.

- IoT in utilities
  - Seen in the electrification of the Upper Blinkwater village of the Eastern Cape.
  - Comprises solar PV, a diesel backup, battery energy storage, and the Siemens SICAM Microgrid Controller, controls the energy source and ensures the efficient use of electricity.
  - With the system, households in the village have at least enough power for a cell phone charger, a kettle, and a TV and satellite dish.
  - Similar systems are deployed in water meters and household solar installations, allowing users to track consumption and save resources.

Trends in South Africa

- South Africa has a number of initiatives supporting technological and sustainable innovation:
  - Policy instruments: The 12L Energy Efficiency Allowance allows qualifying taxpayers to claim a deduction for energy efficiency savings resulting from activities adopted in operations.
  - Finance: The IDC's Machinery, Equipment and Electronics SBU funds digital and energy innovations; the Energy SBU supports microgrid development.
  - Research and development: CSIR's Living Energy Lab explores approaches to the energy transition, which includes micro grid and AI solutions.

Trends in South Africa

- Higher education (in addition to offering courses that cover advanced digital skills):
  - UP's HDTC seeks to establish a smart grid to monitor electricity usage across the precinct, helping the municipality to allocate electricity based on energy requirements.
  - UKZN's Smart Grid Research Centre (with Eskom) is dedicated to research and training on integrating renewable energy through modelling, simulation and real-time analysis.

- While these initiatives exist, barriers remain:
  - Education and training systems (outside of higher education) are not yet fully preparing the workforce for technological change.
  - Poor digital infrastructure (particularly, outside urban areas) limit adoption.
  - Automation may contribute to unemployment, as jobs that entail conducting repetitive tasks may be replaced.
  - Other challenges include high costs of adoption, and cybersecurity risks.

Conclusion

- The electrical equipment industry is undergoing a notable digital transformation, driven by technologies such as IoT, AI, digital twins, AR/VR, and additive manufacturing.
- These technologies enhance efficiency, innovation, and sustainability, but their uptake in South Africa remains limited.
- Industrial innovation is led by foreign entities, requiring stronger domestic support for skills localisation.
- Continued and enhanced collaboration, investment, and skills development are essential if South Africa is to build competitiveness in this industry.

Thank you

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