Volume 9, Issue 5, May – 2024 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2443

Current State and Future Potential of Energy Efficiency and Demand Side Management in the South African Context

Adebayo, Adeyinka Victor[1]
Electrical Department,
University of Johannesburg, South Africa

Opaleye, Emmanuel Taiwo[2]; Oladejo, Ismaheel Oyeyemi[3]
Electrical Engineering Department, The Polytechnic Ibadan

Abstract:- This paper explores the current state and future potential of Energy Efficiency and Demand Side Management (EEDSM) in South Africa. With a heavy reliance on coal for electricity generation, South Africa faces significant environmental and sustainability challenges. Integrating renewable energy sources like wind, water, and solar (WWS) is crucial for reducing greenhouse gas emissions and ensuring energy security. The study highlights the importance of demand-side management in optimising energy consumption and mitigating peak demand pressures. The South African government has implemented various policies and regulatory frameworks to promote EEDSM, focusing on reducing energy consumption through technological innovations and strategic planning. Models such as the Five-Stage Model for Computer Technology Integration, the E-Capacity Model, and the Systemic Planning Model for ICT Integration provide structured approaches to integrating advanced technologies and practices into energy systems. The research includes a comprehensive analysis of South Africa's current energy mix, predominantly coal and nuclear, and projects a shift towards a diversified portfolio dominated by renewable sources by 2050. This transition is expected to create substantial employment opportunities and enhance energy efficiency. Case studies and success stories from both the public and private sectors underscore the economic and environmental benefits of EEDSM initiatives. South Africa can significantly improve its energy efficiency and sustainability by leveraging innovative energy technologies, such as smart grids and smart metering. The findings emphasise the need for continued investment in renewable energy and demand-side management to achieve a more resilient and efficient energy sector.

Keywords:- *Energy Efficiency, Demand Side Management, Renewable Energy, South Africa, Smart Grids, Energy Policy, Sustainability.*

I. INTRODUCTION TO ENERGY EFFICIENCY AND DEMAND SIDE MANAGEMENT (EEDSM)

Renewable energy generation and technology are well covered; however, this is not the only method to achieve sustainability. Energy efficiency is a field worthy of more attention and is the focus of this chapter. Irrespective of the chosen energy source, be it fossil fuels or non-renewables, using them sustainably is equally important (Capillo et al., 2024). Demand side management is a technique to minimise energy usage by shaping it during times of shortage and assisting in flattening out peak demand levels. This can have implications in a variety of different manners. Proper management of how energy is consumed can, in turn, positively affect energy generation, the environment, peace of mind, and financial implications.

(Sameer Hoosain et al., 2023) South Africa is regarded as one of the most attractive investment destinations in the African continent for numerous economic and social reasons. That said, the country's energy grid is known to be heavily reliant on highly unsustainable energy generation, the most notable of which is coal. In fact, in 2016, renewable energy comprised only 1.5% of the total energy generated (Michael et al., 2024). The demand for electricity is significantly less than what is generated, the main reason behind this being the copious amounts of energy generated from non-renewable resources in the country. For this reason, South Africa is actively engaging in renewable energy resources, particularly wind and solar. Renewable energy technology makes up a large part of current discussions and policies in the South African government, as seen through the Integrated Resource Plan of 2019.

➢ *Definition and Importance*

However, while focusing on EEDSM and DSM, there is no clear explanation and consensus on the role and function of Eskom in terms of powers and responsibilities in engaging with both EEDSM and DSM, given the fact that the utility's primary role focuses more on the supply side than the demand side. For this reason, understanding power utilities' involvement with EEDSM and analysing decisions made for the implementation of DSM and not EEDSM must be

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2443

examined to comprehend the role Eskom has to undertake in engaging with EEDSM.

This chapter starts by unpacking the definition and importance of energy efficiency (Harun, 2020). It then explores how the South African government and utilities like Eskom have committed themselves to implementing electricity demand-side management as an alternative or a decision to complement increasing power generation. Demand-side management consists of methods used by power utilities to modify end-user electricity consumption patterns, such that it helps conserve energy and/or enables system efficiency improvement. Electricity Demand Side Management (DSM), as an alternative to, or to complement, generation through EEDSM implementation, is possible where negawatts are induced by the utility on behalf of its consumers, commonly referred to as DSM conservation, and includes load shedding. model for Dispatch—Time-Of-Use (TOD) type large-scale Energy Efficiency and Demand Side Management (EEDSM) program identification and validation for a specific area of South Africa. The resultant schemes are natural extensions of PyPSAZA, their salient features, and the proposed interventions for standardising energy modelling approaches are discussed (Ayobamiji Awosusi et al., 2022).

II. ENERGY LANDSCAPE IN SOUTH AFRICA

The resultant model first accounts for the accurate aggregate residential, commercial, industrial, transportation and other accurate daily/diurnal as well as yearly seasonal composite load profiles utilising a mixed integer linear programming (MILP)

South Africa is world-famous for being one of the biggest and most ideal locations for Solar Photovoltaic (PV) and wind power plant establishments (Hörsch & Calitz, 2017). Given the ambitious targets from the South African government to expand its renewable capacity, a comprehensive, extremely detailed modelling framework based on Python for Power System Analysis (PSA) is proposed to account for the pertinent technical and economic aspects in terms of investment strategies at an exceedingly detailed geographical and temporal grade (Kirli et al., 2021). Subsequently, the primary motivation for formulating a countrywide advanced Composite Load Model (CLM) is to present a correct representation of the various segments of South African society cohesively. To accomplish these goals, we have vested great efforts in developing a feat "from scratch" representative CLM and multilayer Dynamically Evolving Network (DEN) within the PyPSAZA framework.

A. Current Energy Sources and Consumption Patterns

The attached Figure 1 illustrates South Africa's projected energy mix in 2050, emphasising a transition to 100% wind, water, and solar (WWS) for all purposes, including electricity, transportation, heating/cooling, and industry. Here's a detailed analysis of the current energy sources and consumption patterns in South Africa, contextualised with the provided figure:

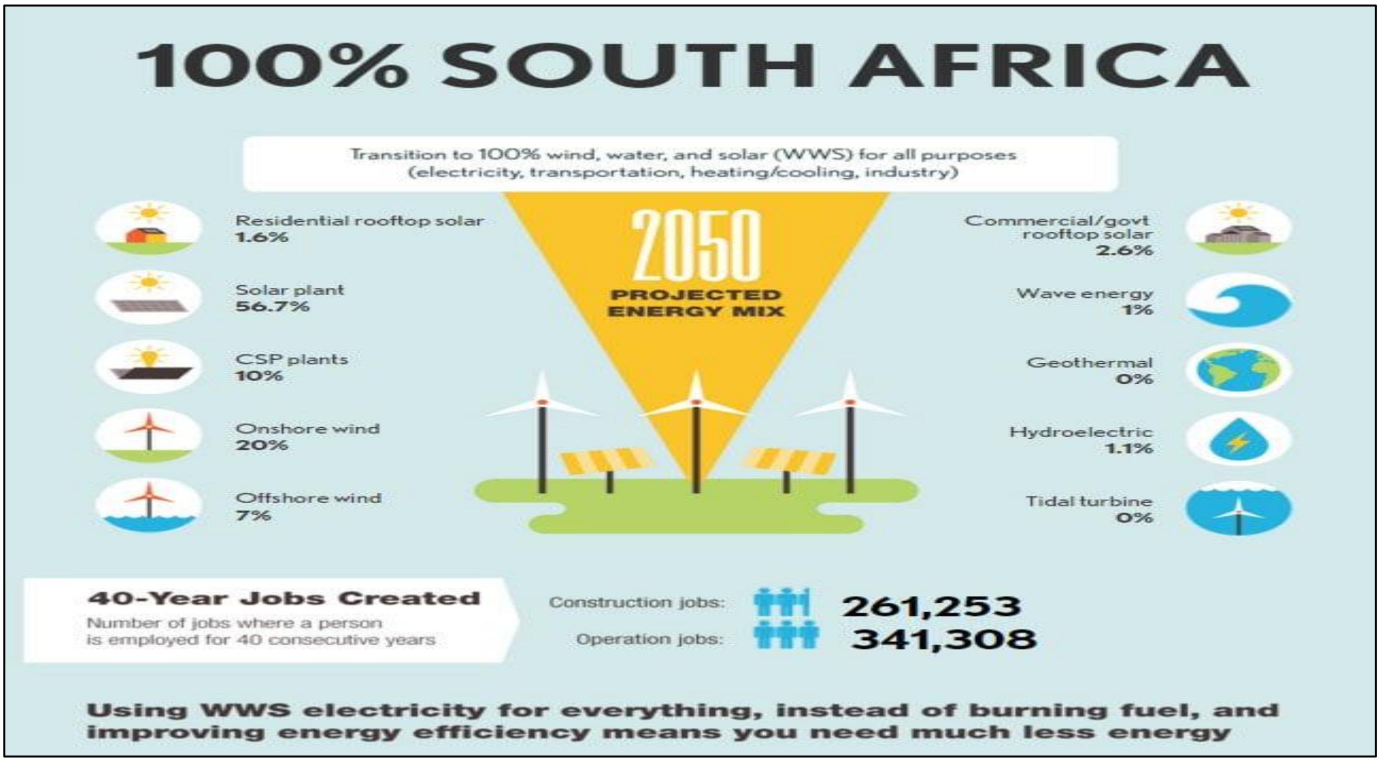

Fig 1: South Africa's Projected Energy Mix in 2050 (MyBroadband, 2015)

B. Current Energy Sources

➢ *Coal:*

- **Percentage**: Approximately 77% of South Africa's electricity is generated from coal.
- **Usage**: Predominantly used for electricity generation.
- **Environmental Impact**: Major contributor to greenhouse gas emissions (Mazwi Mchunu et al., 2023).

➢ *Renewable Energy:*

- **Wind Power**: Currently contributes a small percentage to the national grid but is projected to increase by 2050 significantly.
- **Solar Power**: Includes residential rooftop solar (16%), commercial/government rooftop solar (2.6%), solar plants (10%), and CSP plants (16%).
- **Hydropower**: Accounts for 1.1% of the current energy mix.
- **Geothermal and Offshore Wind**: Emerging sources, with offshore wind expected to constitute 10% by 2050.
- **Waste-to-Energy**: A minor component of the diversification strategy (Jardine et al., 2014).

➢ *Nuclear:*

- **Percentage**: Accounts for about 5% of electricity generation.
- **Usage**: Mainly for base load power (Salahuddin et al., 2019).

➢ *Natural Gas and Oil:*

- **Usage**: Limited role in electricity generation but significant in industrial and residential heating and transportation (F Smit, 2012).

C. Consumption Patterns

➢ *Electricity:*

- **Usage**: Primarily consumed by industrial sectors, residential areas, and commercial buildings.
- **Patterns**: High consumption during peak hours leading to load shedding.

➢ *Transportation:*

- **Energy Source**: Predominantly reliant on petroleum-based fuels.
- **Shift**: Moving towards electric vehicles powered by renewable energy sources.

➢ *Industry:*

- **Energy Source**: Heavy reliance on coal, with increasing adoption of renewable energy for sustainability.

➢ *Residential and Commercial Heating/Cooling:*

- **Energy Source**: Mix of electricity and natural gas.
- **Efficiency**: Improved energy efficiency measures are reducing overall consumption.

D. Future Projections

- **Transition to Renewable Energy**: South Africa aims to shift to 100% WWS by 2050.
- **Job Creation**: The transition is expected to create significant employment opportunities, with 261,253 construction jobs and 341,308 operation jobs over 40 years.
- **Energy Efficiency**: Emphasis on using WWS electricity, reducing the need for fossil fuels, and improving energy efficiency, which will lower overall energy consumption.

The South African provincial population was 44.9 million in 2012 (Jardine et al., 2014). Due to rapid industrialisation and urbanisation, electricity demand grew from 3TWh in 2010 to 218TWh in 2017 (Jardine et al., 2014). Under financial logic and environmental impact considerations, South Africa heavily relies on coal (77%) for electricity production (Mazwi Mchunu et al., 2023). Numerous issues and challenges caused the transition period for the South African electricity sector, including predicting electricity demand, capacity expansion studies, dispatching strategies, and response times (Jardine et al., 2014). The current sources of electricity in South Africa are primarily coal (77%) and nuclear (4.4%) (Salahuddin et al., 2019). The ageing electricity grid is increasingly subjected to faults and failures (F Smit, 2012). The solution to the current crisis involves lowering electricity demand to match supply through inclusionary planning methodologies and strategies, enabling SMMEs to participate in generating and distributing electricity within their business districts. This can lower demand and create extra revenue streams for residents by selling power to the grid at peak periods when demand is high. Such initiatives, particularly in areas like Johannesburg, could provide the city with ad hoc electricity availability and enhance the region's economic resilience.

III. POLICIES AND REGULATIONS SUPPORTING EEDSM IN SOUTH AFRICA

The impetus for energy efficiency and demand side management was further boosted by the promulgation of the National Energy Regulator Act (No. 40 of 2004), which included, amongst others, the Development and Promotion of Renewable Energy, Development and Promotion of co-generation, Investment in Electricity Networks; Deployment of Energy Efficiency Technologies. These provisions facilitated the statutory obligation to grow the electricity sector through diversification and promoting energy efficiency technologies. Furthermore, the National Development Plan (NDP), South Africa's strategic vision for the next twenty years, expressed the government's development objective for promoting energy efficiency in the country as one of the transition objectives of promoting

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2443

investment in clean energy technologies. The NDP has a target of 30% of the final demand to come from energy efficiency-related technologies by 2030.

(Ayobamiji Awosusi et al., 2022) The South African government has implemented several policy instruments to promote energy efficiency and demand-side management in South Africa. These include vision/mission/mandate, high-level policy, white papers, and national strategies (Harun, 2020). The Department of Energy (DoE) plays a critical role in the policy and regulatory development of Demand Side Management (DSM) with the help of a semi-autonomous regulator, the National Energy Regulator of South Africa (NERSA). In 2008, the DoE launched the Integrated Resource Plan (IRP) 2010, covering its adoption in March 2011 up to 2030, which aimed to (amongst other things) promote energy efficiency and reduce demand side management (DME-DoE, 2008). The Energy Efficiency Strategy (EES) resulted from this effort, and it has never been fully implemented. A revised version of the Energy Efficiency Strategy for South Africa was developed, and the Department of Energy was appointed to develop a National Energy Efficiency Action Plan (NEEAP). This plan includes “the national energy savings target for South Africa, a framework for energy management as well as concrete actions necessary for achieving the energy savings targets”.

- *National Energy Efficiency Strategy*

The government has identified various industrial sectors as targets for energy efficiency interventions, including mining; chemical and petrochemical; automotive; iron and steel; non-ferrous metals; pulp and paper; fertilisers; water and wastewater; agriculture; the chemicals and allied products sector; and the food, beverages, and tobacco sector (Capillo et al., 2024). Industries operating with minimum energy intensity levels were included under the EEDSM Incentive Programme, where energy users with specific calendar year electricity consumption values had to achieve specified targets by implementing the EEDSM tune-up incentive programme.

The 2015 South African Energy Efficiency Strategy and the Action Plan are both national in scope and strategic in nature (Michael et al. et al., 2024). The strategy is based on the country’s National Energy Policy, the overarching goals of which have been to address the triple challenges of energy poverty, energy security and climate change while promoting sustainable development (Di Foggia, 2020). The strategy and the action plan go beyond merely reducing energy consumption and energy-related emissions. They incorporate public-private partnerships, industrial policy, research and development, consumer awareness, economic growth and job creation in their objectives, interventions, and actions. The continuation of the ESCo Programme is consistent with the Strategy and Policy; it involves demand-side management of the purchased electricity through more efficient consumption and limited renewable supply-side interventions but operated by the utility on behalf of customers.

IV. TECHNOLOGIES AND PRACTICES FOR EEDSM

Increased participation of electric vehicles (buses, cars, and mini-buses) in the transport sector will result in more energy-efficient commuting options and a reduction in the number of private cars on the roads, thereby mitigating congestion and saving energy.

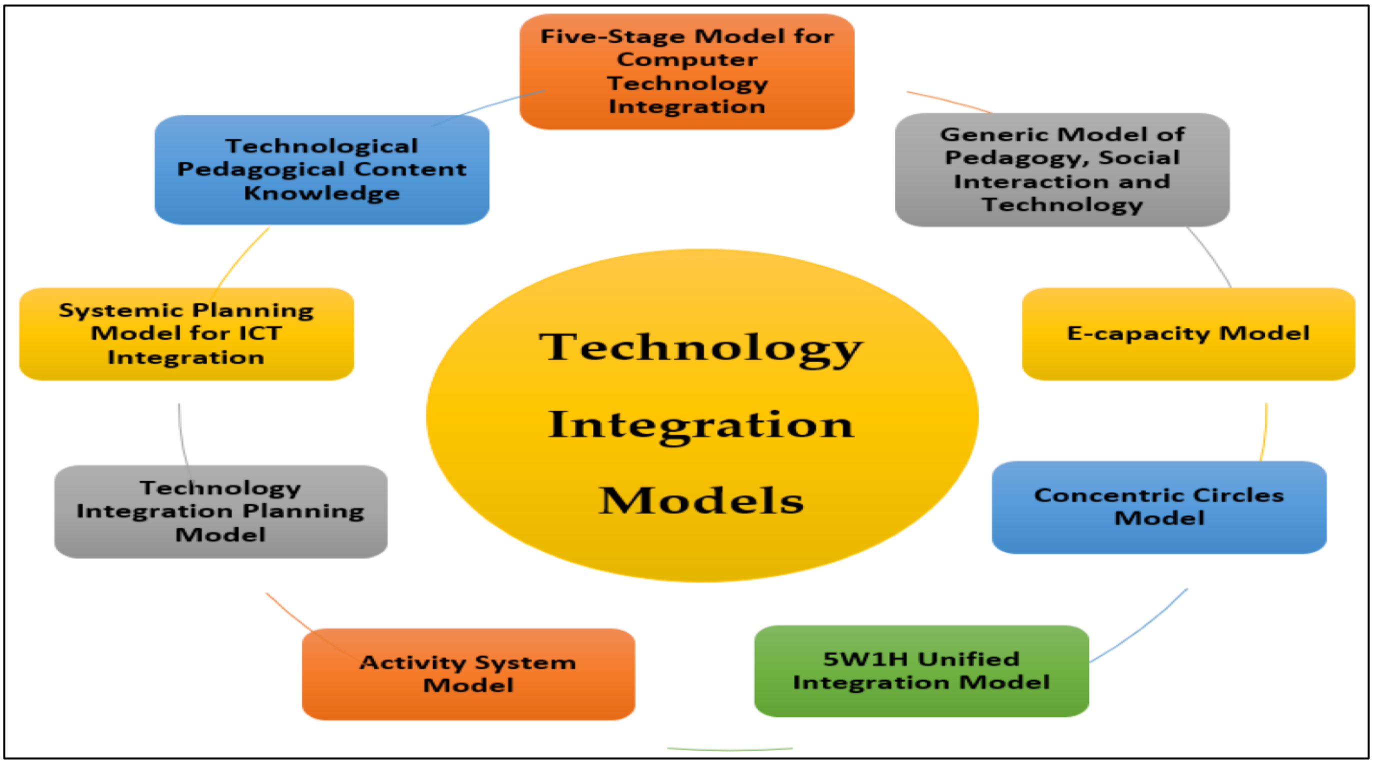

Fig 2: Various Models for Integrating Technology into Different Systems

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2443

A shift from internal combustion engines to electric vehicles will also improve local air quality, leading to better health. The increased use of lithium-ion batteries in portable electronics and electric vehicles exacerbates concerns about its ultimate disposal and foments the race to develop environmentally acceptable secondary recycling technology (Chukwudi et al., 2023). Fostering a market for durable, repairable, and recyclable products is imperative for avoiding the waste issue of these critical raw materials. Hence, new applications of lithium-ion batteries for supporting EEDSM are a new topic that has been discussed. Figure 2 highlights various models for integrating technology into different systems, which can be leveraged for Energy Efficiency Demand-Side Management (EEDSM) in South Africa. Here's an analysis of how these models can be applied to enhance EEDSM practices:

- **Model for Computer Technology Integration:** This model guides the integration of advanced monitoring and control technologies into energy systems. By following stages such as entry, adoption, adaptation, appropriation, and innovation, South Africa can systematically incorporate intelligent grids and IoT devices to optimise energy use.
- **Generic Model of Pedagogy, Social Interaction, and Technology:** Emphasizing the role of education and social interaction in technology adoption, this model can be used to design programs that educate consumers and businesses about the benefits of energy efficiency technologies and practices, promoting widespread adoption.
- **E-Capacity Model:** Focused on building digital capabilities, this model can help utilities and industries develop the necessary skills and infrastructure to implement and manage energy-efficient technologies effectively.
- **Concentric Circles Model:** This model involves multiple layers of integration and influence and can be used to develop comprehensive EEDSM programs that include policy development, technological innovation, stakeholder engagement, and consumer behaviour change.
- **5W1H Unified Integration Model:** This model addresses Who, What, Where, When, Why, and how and helps plan and execute energy efficiency projects. It ensures that all aspects of EEDSM, from stakeholder involvement to technological implementation, are thoroughly considered.
- **Activity System Model:** Focusing on the interaction between various system components, this model can analyse and optimise the interplay between energy-saving technologies and practices, ensuring a cohesive approach to EEDSM.
- **Technology Integration Planning Model:** This model provides a framework for systematically planning the adoption of new technologies. It helps South African utilities and businesses develop detailed plans for integrating energy-efficient technologies, including timelines, resource allocation, and performance metrics.
- **Systemic Planning Model for ICT Integration:** Emphasizing strategic planning and systemic integration of ICT, this model guides the implementation of smart meters, energy management systems, and other ICT-based solutions that enhance energy efficiency.
- **Technological Pedagogical Content Knowledge:** This model combines knowledge of technology, pedagogy, and content to help design training programs for energy managers and technicians, ensuring they have the skills and knowledge to use energy-efficient technologies effectively.

By utilising these models, South Africa can develop and implement effective EEDSM strategies that integrate technology and practices to reduce energy consumption, improve efficiency, and promote sustainable energy use. These models provide a structured approach to technology integration, ensuring that EEDSM initiatives are comprehensive, well-planned, and effective in achieving their goals. Establishing the impacts of technologies and interventions on improving EEDSM in South Africa remains fundamental to enhancing awareness of EEDSM. Innovative energy technologies and their proposed applications in a smart grid infrastructure have been evaluated. Smart metering is a perfect example of a technology that has the potential to revolutionise how electricity is managed and paid for, resulting in both immediate and remote benefits to utilities and consumers. Cost-efficient lighting has also been proposed as one of the most effective ways of reducing energy consumption in office buildings, universities, and households.

➢ *Smart Grids and Metering Technologies*

(Chen et al., 2023) The existing power grid is decoupled and lossy, and end customers do not have visibility of the market price of electricity. To address this, a common vision among researchers and practitioners is smart grids and demand side management (DSM), in which an advanced metering infrastructure is the first step towards a smart grid. However, an advanced metering infrastructure does not make the grid bright by itself; it just enables a smart grid. A smart grid should offer several features, and the energy efficiency (EE) feature is related to controlling the end customer's load. Several technologies and systems have been proposed to monitor customer loads in real time and to disconnect or switch them on or off as required. (Battista Gaggero et al., 2021) A possible future of the electricity ecosystem for 2040 is perceived as a hierarchy of distribution systems, each representing an independent micro smart grid operated by the associated owner of the generation stations and the residential and industrial micro-grids. Each works autonomously, searching for an equilibrium while maximising transacted power in the local electricity markets. These utilities and industrial sector microgrids are all embedded in large and medium-sized distribution systems. They may also opt to provide withdrawal capacity to the upstream high-voltage grid. Nevertheless, the interacting constraints stemming from financial or technical instructions of corporation owners do not necessarily lead to an efficient operation of the entire system regarding economic or energy losses.

V. CASE STUDIES AND SUCCESS STORIES

Given the comprehensive list of drivers and inhibitors noted for EEDSM in the public and private sectors, it appears that there can be a comprehensive EEDSM strategy; however, the customization of this strategy across the public and private sectors must be considered. 4 important drivers were identified for both the private and public sectors: tax and regulatory systems, the potential for savings and ROI Periods, potential increases in energy efficiency, and renewable energy supply. Interestingly, many drivers appeared to be government-specific: a paying obligation structure, the physical condition and age of assets and infrastructure, future energy security, and service delivery governance. Rising energy costs are a major reason 90% of companies initiate cost savings. Special factors in the public sector were better EEDSM coordination and the unintended spending of government buildings.

This study aimed to answer the research question, "What are the opportunities and challenges for implementing EEDSM in the public and private sectors in South Africa in the long term." This was achieved through two sub-objectives: "To investigate EEDSM activities and success cases in the public and private sectors in the South African context using two case studies" and "To compare common drivers and inhibitors affecting EEDSM success in the public and private sectors" (Ringel et al., 2019). We reviewed success cases of industrial and public sector energy efficiency in two Indo-Pacific economies: South Africa and Bahrain (Di Foggia, 2020). There has been a significant rise in EEDSM in South Africa, and significant changes have been noticed in the past 3 years (new EEDSM initiatives, engagement of the executors, and systemic maturity).

➢ *Impact of EEDSM on Businesses and Industries*

Most stakeholders, including governments, businesses, and research communities, are dedicated to improving EEDSM in the grid system. The effect of EEDSM can be refined from different perspectives. Generally, more attention has been focused on final user benefits (as well as domestic users) rather than on their impact on industries. The economic impact on the market is a critical aspect and needs to be considered to maintain economic growth and environmental sustainability. Electricity is one of the most critical operational costs in the South African economy. Businesses and industries are the largest consumers of electricity and, therefore, potential contributors to a load reduction strategy focused on grid and system support while avoiding cost increases from external energy providers. Most industrial loads can withstand interruptions in supply with minimal harmful effects. In contrast, other load types might have the ability to be utilised in peak-demand environments in a controlled manner (ensuring no or little impact on the business).

A company's energy efficiency performance strongly influences the cost structure, associated product prices, and the organization's ability to compete internationally. Energy costs are one of the main operational costs in the manufacturing sector, ultimately influencing the overall economy (Malinauskaite et al., 2020). Energy management and demand-side management expertise have grown tremendously in recent years. For many businesses, energy cost is second only to raw materials when determining operating costs and has, as a result, grown tremendously in importance to the industry. Electricity tariffs in South Africa have also grown significantly over the last few years, which will likely continue. This, along with the necessity for rolling blackouts due to electricity shortages in South Africa, has led to a renewed and more widespread focus on energy efficiency (Gordić et al., 2014). Implementing energy efficiency strategies is no longer optional but necessary for businesses and industries.

VI. CONCLUSION

There are many opportunities of reducing carbon emission in South Africa. Every consuming sector has different ways of reducing the level of greenhouse gas (GHG) emissions, which can be realized using different technologies such as EE, DSM, renewable energy, solar water heating, etc. Although, the South African government has made tremendous progress towards implementing strategy that mitigate the effects of GHG emissions. There are many factors that affect the progress to date, such as institutional barriers, capacity limitation and some practical problems. Some of these barriers and limitations can be addressed by adapting lessons from international experience to South Africa.

The EE interventions in the residential, commercial and industrial can be scaled up by the help of Pilot SOP currently implemented in South Africa by ESKOM and this will go a long way to mitigate the goal of carbon emission.

REFERENCES

[1]. Capillo, A., De Santis, E., Massimo Frattale Mascioli, F., & Rizzi, A. (2024). An Online Hierarchical Energy Management System for Energy Communities, Complying with the Current Technical Legislation Framework. [PDF]

[2]. Sameer Hoosain, M., Sena Paul, B., Doorsamy, W., & Ramakrishna, S. (2023). Comparing South Africa's Sustainability and Circular Economic Roadmap to The Rest of the World. ncbi.nlm.nih.gov

[3]. Michael Smarte Anekwe, I., Okiemute Akpasi, S., Mzwandile Mkhize, M., Zhou, H., Tawanda Moyo, R., & Gaza, L. (2024). Renewable energy investments in South Africa: Potentials and challenges for a sustainable transition - a review. ncbi.nlm.nih.gov

[4]. Harun, M. (2020). Pursuing More Sustainable Energy Consumption by Analyzing Sectoral Direct and Indirect Energy Use in Malaysia: An Input-Output Analysis. [PDF]

[5]. Ayobamiji Awosusi, A., Kutlay, K., Altuntaş, M., Khodjiev, B., Bonah Agyekum, E., Shouran, M., Elgbaily, M., & Kamel, S. (2022). A Roadmap toward Achieving Sustainable Environment: Evaluating the Impact of Technological Innovation and Globalization on Load Capacity Factor. ncbi.nlm.nih.gov

[6]. Hörsch, J. & Calitz, J. (2017). PyPSA-ZA: Investment and operation co-optimising integrating wind and solar in South Africa at high spatial and temporal detail. [PDF]
[7]. Kirli, D., Hampp, J., van Greevenboek, K., Grant, R., Mahmood, M., Parzen, M., & Kiprakis, A. (2021). PyPSA meets Africa: Developing an open-source electricity network model of the African continent. [PDF]
[8]. Mazwi Mchunu, N., Okechukwu Onatu, G., & Gumbo, T. (2023). The impact of Electricity Blackouts and poor infrastructure on the livelihood of residents and the local economy of City of Johannesburg, South Africa. [PDF]
[9]. Salahuddin, M., Gow, J., Idris Ali, M., Rahat Hossain, M., Shaheen Al-Azami, K., Akbar, D., & Gedikli, A. (2019). Urbanization-globalization-CO(2) emissions nexus revisited: empirical evidence from South Africa. ncbi.nlm.nih.gov
[10]. Di Foggia, G. (2020). Effectiveness of energy efficiency certificates as drivers for industrial energy efficiency projects. osf.io
[11]. Chukwudi Udeagha, M. & Christoffel Breitenbach, M. (2023). Revisiting the nexus between fiscal decentralization and CO(2) emissions in South Africa: fresh policy insights. ncbi.nlm.nih.gov
[12]. Strielkowski, W., Gorina, L., Korneeva, E., & Kovaleva, O. (2023). Energy-saving technologies and energy efficiency in the post-pandemic world. [PDF]
[13]. Chen, Z., Moradi Amani, A., Yu, X., & Jalili, M. (2023). Control and Optimisation of Power Grids Using Smart Meter Data: A Review. ncbi.nlm.nih.gov
[14]. Battista Gaggero, G., Marchese, M., Moheddine, A., & Patrone, F. (2021). A Possible Smart Metering System Evolution for Rural and Remote Areas Employing Unmanned Aerial Vehicles and Internet of Things in Smart Grids. ncbi.nlm.nih.gov
[15]. Ringel, M., Laidi, R., & Djenouri, D. (2019). Multiple Benefits through Smart Home Energy Management Solutions -- A Simulation-Based Case Study of a Single-Family House in Algeria and Germany. [PDF]
[16]. Malinauskaite, J., Jouhara, H., Egilegor, B., Al-Mansour, F., Ahmad, L., & Pusnik, M. (2020). Energy efficiency in the industrial sector in the EU, Slovenia, and Spain. ncbi.nlm.nih.gov
[17]. Gordić, D., Babić, M., Jelić, D., Konćalović, D., & Vukašinović, V. (2014). Integrating Energy and Environmental Management in the Wood Furniture Industry. ncbi.nlm.nih.gov