



Hiedberg/consult

Transforming Sierra
Leone's Energy Sector with
Data-Driven Modernization

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Foreward

At Hiedberg, we are dedicated to supporting stakeholders in Sierra Leone as they navigate this crucial energy transformation.

As Sierra Leone embarks on a critical journey toward economic growth, the modernization of its energy sector is paramount. In a country where access to reliable and affordable energy remains a significant challenge, the ability to harness data and emerging technologies is not just an opportunity—it is a necessity. At Hiedberg, we are dedicated to supporting stakeholders in Sierra Leone as they navigate this crucial transformation. This white paper, **Transforming Sierra Leone's Energy Sector with Data-Driven Modernization**, underscores our commitment to helping the nation overcome its energy challenges through strategic data innovation.

The insights and strategies presented in this white paper are designed to provide actionable guidance tailored to the unique context of Sierra Leone. Whether you aim to improve energy access, optimize operational efficiency, or explore new market opportunities, we believe this document will be an invaluable resource in your efforts to drive meaningful change.

Thank you for taking the time to engage with our findings. We look forward to the opportunity to collaborate with all relevant stakeholders to advance Sierra Leone's energy sector toward a more sustainable and prosperous future.

Best Regards,

Miriam MacCarthy

CEO, Hiedberg



Current State

The energy sector faces substantial hurdles. Approximately 70% of the population still lacks access to electricity and those who do often experience frequent outages due to inadequate and aging infrastructure.

Sierra Leone's energy sector is at a pivotal moment, with the Electricity Distribution and Supply Authority (EDSA) at the forefront of efforts to enhance the distribution and supply of electricity across the nation. EDSA operates under the Sierra Leone Electricity and Water Regulatory Commission (SLEWRC), ensuring that the nation's standards and policies are adhered to. EDSA is working to address significant challenges while leveraging strategic partnerships to improve service delivery and infrastructure.²

Despite these efforts, the energy sector faces substantial hurdles. Approximately 70% of the population still lacks access to electricity and those who do often experience frequent outages due to inadequate and aging infrastructure.⁴ Electricity theft, discrepancies in meter readings, and billing inaccuracies are also prevalent, particularly with postpaid meters. These issues contribute to high technical losses and inefficiencies within the system.²

The Sierra Leonean government and EDSA have recognized these challenges and are actively pursuing initiatives to address them. Key partnerships have been established with international organizations and private entities to support infrastructure improvements, capacity-building projects, and renewable energy development.⁴



Millennium Challenge Corporation (MCC): A \$480 million grant has been secured to expand access, enhance reliability, and ensure sustainability in the electricity sector through infrastructure development and policy reforms.⁵

World Bank & African Development Bank: These institutions provide crucial support for rural electrification, renewable energy projects, and general infrastructure improvements.³

Infinity Power: Committed to developing 1 gigawatt of renewable energy capacity, which is set to significantly boost the country's energy sustainability.⁶

Karpowership: A Turkish company providing approximately 80% of Sierra Leone's electricity through dual-fuel floating power plants.⁷

Renewable energy efforts are gaining momentum, particularly through the Bumbuna Hydroelectric Project, which remains a cornerstone of the country's energy generation. Additionally, projects like Winch Energy's construction of 24 mini solar plants in northern Sierra Leone are expected to directly benefit over 30,000 people, marking a significant step in rural electrification.³

Furthermore, technological initiatives like the Smart Power pilot program aim to modernize EDSA's operations by reducing electricity theft and improving meter accuracy. This is part of a broader push to enhance efficiency and sustainability within the sector.²

Looking ahead, the impending drilling of oil and gas, led by the Petroleum Directorate of Sierra Leone (PDSL), will further diversify the country's energy landscape. Negotiations with qualified companies are already in progress, signaling a new chapter in Sierra Leone's energy development.³

The government's ambitious targets, outlined in the 2015 Sustainable Energy for All, aim to increase electricity access from 13% in 2013 to 92% by 2030. This includes a substantial expansion in renewable energy, with plans to install 293 MW of renewable energy capacity (excluding large hydropower) by 2030. Despite these goals, progress has been slow, and the lack of reliable energy remains a major impediment to Sierra Leone's socio-economic development.³

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Future Outlook

Sierra Leone's energy sector is positioned for growth, with plans to diversify energy sources and expand access to underserved regions. The government's commitment to renewable energy and rural electrification, coupled with international support, offers a pathway to a more reliable and sustainable energy future.¹

However, achieving these goals will require addressing the existing infrastructure and technological deficits particularly related to data.



Gap Analysis

By focusing on data infrastructure improvements, data regulation reform, and the expansion of tracking and access to data, the country can significantly enhance energy access, reliability, and sustainability.

With targeted interventions and strategic partnerships, Sierra Leone can address the critical gaps in its energy sector, through strengthening the Electricity Distribution and Supply Authority (EDSA). By focusing on data infrastructure improvements, data regulation reform, and the expansion of tracking and access to data, the country can significantly enhance energy access, reliability, and sustainability. The following areas highlight the primary gaps and opportunities for development:

Data Regulatory and Policy Framework

The regulatory environment in Sierra Leone could benefit from clarity and consistency to attract and sustain private investment in the energy sector. Although efforts have been made to create mini-grid regulations and liberalize the electricity supply, further reforms are required to streamline processes, provide a stable investment climate, and improve data management regulations.²

Key Actions

- > **Clarify Regulatory Roles:** Clearly define the roles and responsibilities of different government agencies, and streamline the approval process for how and when data can be collected, shared, and utilized within the sector. This will help ensure consistent and reliable data management, which is critical for informed decision-making and investment.
- > **Incentivize Renewable Energy:** Implement policies that incentivize the development of renewable energy projects, such as tax breaks, subsidies, and risk guarantees for investors. These policies should also include provisions for data transparency and accessibility to monitor project performance and ensure accountability.

Infrastructure Development & Modernization

Sierra Leone's energy infrastructure is outdated and insufficient to meet the growing demand. The current installed capacity of 113 MW is far below what is needed to achieve widespread electrification.³ Substantial investment in both generation and distribution infrastructure is required to reduce the frequent outages and technical losses that plague the system

Key Actions

- > **Upgrade and Expand Grid Infrastructure with Data-Driven Tracking Technology:** Prioritize the modernization of existing grid infrastructure and the expansion of the grid to underserved regions, particularly rural areas. Integrate advanced tracking technology to monitor real-time performance, identify inefficiencies, and optimize energy distribution. This data-driven approach will enhance grid reliability and help reduce technical losses.
- > **Increase Generation Capacity:** Focus on increasing installed capacity, particularly through renewable energy sources such as hydropower and solar, to reduce dependence on expensive and polluting fossil fuels.¹ Implement data management systems to monitor energy production and consumption, ensuring that new capacity is efficiently utilized and contributes to grid stability.

Financial and Technical Capacity Building

EDSA and other relevant agencies face significant challenges in terms of financial and technical capacity. Limited access to financing, coupled with a lack of technical expertise, hampers their ability to undertake large-scale energy projects and implement advanced technologies.²

Key Actions

- > **Develop Financial Investment Data Mechanisms:** Establish innovative financing mechanisms, such as public-private partnerships and green bonds, to mobilize the necessary capital for energy projects. Integrate robust data management systems into these mechanisms to track investments, monitor project outcomes, and ensure transparency and accountability.
- > **Capacity Building and Training:** Invest in capacity-building and training programs for EDSA staff and other stakeholders to enhance technical expertise. Focus on improving data management and project management skills, enabling more effective planning, execution, and evaluation of energy projects

Data-Driven Decision Making

Effective decision-making in the energy sector requires accurate and comprehensive data on energy consumption, infrastructure performance, and resource availability. Currently, data collection and analysis in Sierra Leone are limited, leading to inefficiencies and suboptimal planning.²

Key Actions

- > **Implement Smart Technologies:** Deploy smart meters and other digital tools to improve data collection on energy consumption, grid performance, and technical losses.
- > **Strengthen Data Analysis Capabilities:** Build the capacity of EDSA and other agencies to analyze energy data and use it to inform policy and investment decisions.

Risk Mitigation

Several risks pose significant challenges to the successful implementation and sustainability of energy projects. These risks range from operational inefficiencies and regulatory uncertainties to technical failures and cybersecurity threats. Addressing these risks is crucial for ensuring the reliability, accessibility, and sustainability of energy supply across the country.

The table below categorizes these risks presenting tailored mitigation strategies to reduce their potential impact and highlight the critical data that needs to be tracked.

Risk	Solution	Risk Level	Category	Critical Data
Inadequate Infrastructure Development	<p>Prioritize and secure financing for infrastructure projects, including public-private partnerships and international funding.</p> <p>Conduct regular assessments to ensure projects are on track.</p>	High	Operational	Project progress data, financing data, budget utilization, project completion timelines
Regulatory Uncertainty and Lack of Clear Policy Framework	<p>Collaborate with stakeholders to clarify and streamline regulatory processes.</p> <p>Implement policy reforms that create a stable investment environment.</p>	High	Compliance	Regulatory approvals, policy updates, stakeholder feedback, investment climate metrics
Technical Failures in Grid Expansion and Maintenance	<p>Implement regular maintenance schedules and upgrade existing grid infrastructure.</p> <p>Train EDSA personnel in modern grid management techniques.</p>	High	Technical	Maintenance logs, grid performance metrics, equipment failure rates, personnel training records
Data Collection and Accuracy Issues	<p>Deploy smart meters and data collection technologies to enhance the accuracy of energy consumption data.</p> <p>Regularly validate and cross-check data for consistency</p>	High	Technical/Operational	Energy consumption data, meter accuracy rates, data validation records, data consistency checks

Risk	Solution	Risk Level	Category	Critical Data
<p>Cybersecurity Threats to Energy Infrastructure</p>	<p>Implement robust cybersecurity measures, including encryption, firewalls, and regular security audits.</p> <p>Conduct ongoing training for staff on cybersecurity best practices.</p>	<p>High</p>	<p>Security</p>	<p>Security audit logs, incident reports, encryption status, firewall activity logs, staff training records</p>
<p>Lack of Skilled Workforce for Energy Sector Projects</p>	<p>Invest in training programs and capacity-building initiatives to develop the necessary technical skills within EDSA and the broader energy sector.</p> <p>Partner with educational institutions for specialized training.</p>	<p>Medium</p>	<p>Operational</p>	<p>Training program participation rates, skills assessment data, workforce competency metrics</p>
<p>Environmental Impact of Energy Projects</p>	<p>Conduct thorough environmental impact assessments (EIAs) before project initiation.</p> <p>Implement mitigation strategies to minimize adverse environmental effects.</p>	<p>High</p>	<p>Environmental</p>	<p>Environmental impact data, EIA reports, mitigation strategy effectiveness, compliance with environmental regulations</p>
<p>Difficulty in Integrating Renewable Energy into Existing Grid</p>	<p>Conduct comprehensive studies and simulations to ensure the compatibility of new renewable energy sources with the existing grid.</p> <p>Develop a phased integration plan.</p>	<p>Medium</p>	<p>Technical</p>	<p>Grid compatibility studies, renewable energy integration timelines, grid stability metrics</p>



Case Study: Data Transformation in the Energy Sector

Introduction

A West Africa-based energy company is focused on increasing access to energy across the country. Excited about innovative ways to increase customer support and operational efficiency, this organization is keen on utilizing its data to innovate and improve its decision-making processes.

The Problem

As the firm seeks to become more data-driven in its operations, it faces challenges in efficiently managing and analyzing large volumes of data. These issues include:



Data Silos: The data is dispersed across various systems, making it difficult to access and analyze comprehensively.



Data Quality and Consistency: There are variations in data quality and format that hinder effective analysis and interpretation.



Real-Time Access: There's limited real-time access to data for immediate decision-making.

The Solution

To address these challenges, Hiedberg Consult led the energy company on a transformative journey to harness the power of data through a comprehensive data strategy. This strategy aimed to drive operational efficiency, enhance customer satisfaction, and promote sustainable growth.

Assessing Data Sources and Infrastructure Setup

We assessed data sources, defined integration requirements using Kafka and data dumps, set up AWS infrastructure (S3, MKS, Glue, EKS), configured Apache NiFi for automation, deployed Apache Atlas for metadata, used Apache Airflow for orchestration, Dremio for fast queries, and implemented data quality monitoring tools and dashboards.

Managing Data Consolidation, Quality, and Governance

We consolidated data from Polymorph, Hubtel, and BPS using Iceberg and Dremio for queries, implemented data quality monitoring tools for integrity, used AWS SageMaker for machine learning, and employed Tableau/Power BI for visualization. We established data governance with Apache Atlas for cataloging and audits, integrating meter readings for enhanced analytics.

Enhancing Data Integration and Analytics

We completed the integration of historical data from CMS and initiated integration from former CBIS for a comprehensive data repository. We utilized AWS SageMaker for machine learning, Tableau/Power BI for dynamic reports, extended ETL processes for analytics, and continuously improved system rollout based on feedback.

Automating Data Extraction and Transformation

We automated data extraction from Polymorph, Hubtel, and BPS, loading raw data (Bronze) into the Data Lakehouse. We cleaned, transformed, and applied quality checks to ensure data integrity. We utilized Apache Atlas for metadata and data quality monitoring tools.

Implementing Data Processing and Security Infrastructure

We developed pipelines for metering readings and asset management to ensure efficiency. We also deployed tools for real-time data quality monitoring and constructed a SIEM system using Elastic for security threat detection. We utilized AWS SageMaker for machine learning and Tableau/Power BI for dynamic insights.



The Impact

Our solution created a unified platform for data management and analysis that yielded significant results:



Increased Profitability

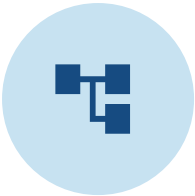
We worked with the energy firm to streamline and organize data. This strategy helped increase the visibility into accounts receivable across residential and commercial clients. Revenue collection was optimized and financial losses were minimized, leading to an approximate 20% increase in profitability.

Through mining customer data and energy usage, we were able to help the energy firm explore new revenue streams through data monetization and increased revenue by 5%.



Improve Customer Satisfaction

Data-driven personalized services and real-time insights into consumption patterns enhanced service quality and customer engagement. This change resulted in an increase of 25 Net Promoter Score (NPS) points and a 15% reduction in customer complaints.



Enhance Operational Efficiency

By implementing predictive analytics and real-time monitoring, we streamlined operations and maintenance processes which improved operational efficiency by approximately 30% and reduced downtime by 20%.



Ensure Compliance and Security

We implemented data security measures and ensured compliance with regulatory requirements which decreased security incidents by 40% and helped achieve 100% regulatory compliance.

Conclusion

Sierra Leone's energy sector stands at a critical juncture, with significant opportunities to transform its infrastructure, expand access, and embrace renewable energy. While challenges such as limited infrastructure, regulatory uncertainties, and technical constraints remain, the strategic interventions outlined in this white paper provide a clear path forward.

By leveraging partnerships, and investing in modernization and data transformation, Sierra Leone can build a more resilient and sustainable energy system that supports its long-term socio-economic development.

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