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A FEASIBILITY STUDY ON UNDERGROUND INFRASTRUCTURE IMPLEMENTATION TO ENHANCE DHAKA'S ELECTRICAL GRID RELIABILITY

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ABSTRACT

This study systematically reviews the feasibility of implementing underground power infrastructure to enhance the reliability of Dhaka's electrical grid. Given the city's frequent power outages due to adverse weather and aging overhead power lines, this review synthesizes findings from peer-reviewed journal articles, technical reports, conference papers, and case studies published between 2010 and 2023. The review highlights the significant benefits of underground systems, including improved grid reliability and resilience, reduced outages, and enhanced urban aesthetics and safety. However, it also identifies substantial economic and technical challenges, such as high initial installation costs and complex maintenance requirements. Recent technological advancements, such as improved cable materials and installation techniques, have made underground power lines more feasible and cost-effective. Case studies from cities like Amsterdam, London, New York, and Toronto provide valuable insights into successful implementation strategies, emphasizing the importance of integrated urban planning and stakeholder collaboration. These findings offer a robust foundation for policymakers, utility companies, and urban planners to consider transitioning Dhaka's power infrastructure to an underground system, aiming to mitigate the impacts of severe weather and enhance overall grid reliability.

1 Introduction

The reliability of electrical grids is fundamental to the socio-economic stability and development of urban areas. A robust electrical grid ensures an uninterrupted power supply, which is essential for functioning businesses, hospitals, schools, and households. According to Bosisio et al. (2023), reliable electricity access is a cornerstone of economic growth and social well-being. It enables industrial operations, supports digital infrastructure, and ensures the smooth running of essential services. Without a reliable power supply, cities face significant disruptions that can hinder economic progress and reduce the quality of life for residents. In urban centers like Dhaka, the capital city of Bangladesh, the electrical grid's reliability is a pressing concern due to frequent disruptions caused by adverse weather conditions and aging infrastructure (Chowdhury et al., 2018). These disruptions cause inconvenience and pose risks to safety and economic stability.

Dhaka's electrical grid predominantly relies on overhead power lines, particularly vulnerable to weather-related disruptions such as heavy rainfall, storms, and flooding. According to Miskat, et al. (2021), these adverse weather conditions can cause significant damage to power lines, leading to widespread outages and economic losses. Overhead lines are exposed to the elements, making them more susceptible to physical damage from falling trees, high winds, and lightning strikes. In addition, the tropical climate of Dhaka exacerbates these vulnerabilities, with monsoon seasons bringing intense rain and winds that can easily topple or damage power lines. As a result, the current infrastructure struggles to provide a consistent and reliable power supply, affecting the daily lives of residents and the operations of businesses. Frequent power outages disrupt commerce, healthcare services, and everyday activities, highlighting the need for more resilient power infrastructure.

In recent years, underground power infrastructure has emerged as a viable alternative to traditional overhead power lines. Underground systems are less vulnerable to weather-related disruptions and have been shown to reduce the frequency and duration of power outages (Islam et al., 2021). These systems involve burying electrical cables below ground level, protecting them from external environmental factors. By moving power lines underground, cities can significantly enhance the resilience of their electrical grids. The adoption of underground infrastructure is part of a broader trend toward modernizing and hardening electrical grids to withstand natural and artificial hazards. Underground cables are not exposed to the elements and are less likely to suffer weather-related damage. This increased resilience can result in fewer outages and a more reliable power supply for urban areas.

However, the implementation of underground power infrastructure presents several economic and technical challenges. The initial costs of installing underground cables are significantly higher than overhead lines due to the need for excavation, specialized materials, and advanced installation techniques (Chowdhury et al., 2020). The construction process is more complex and labor-intensive, requiring extensive planning and coordination. Additionally, underground systems necessitate specialized equipment and materials to ensure they are insulated and protected from underground environmental factors such as soil moisture and temperature fluctuations. Furthermore, the technical complexity of maintaining underground systems requires skilled labor and advanced diagnostic tools. Identifying and repairing faults in underground cables can be more challenging and time-consuming than overhead lines. Despite these challenges, the long-term benefits of reduced maintenance costs and enhanced grid reliability make underground infrastructure an attractive option for urban areas prone to frequent power outages. The reduced need for regular maintenance and the lower incidence of outages can offset the higher initial installation costs.

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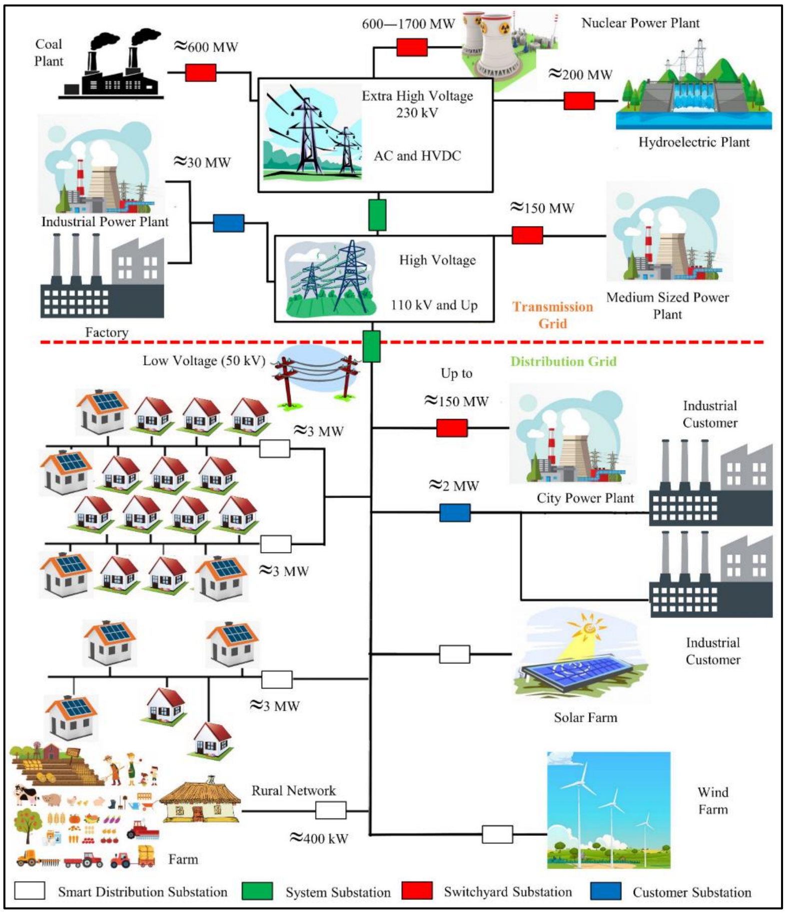
Figure 1: Prospective power network of Bangladesh after integrating renewable energy sources



Dhaka's consideration of underground infrastructure must also consider recent developments in technology and urban planning. Advanced cable materials, installation techniques, and grid management systems have made underground power lines more feasible and cost-effective (Cau et al., 2014). For instance, modern insulation materials and improved cable designs have enhanced the durability and performance of underground systems. New technologies allow for better monitoring and management of underground power lines, making detecting and addressing issues easier before they lead to outages(Chowdhury, 2022). Urban planning initiatives that integrate underground utilities with other infrastructure projects can also reduce overall costs and disruption during installation. Coordinated efforts to install underground power lines alongside other infrastructure projects, such as road construction or water supply improvements, can lead to cost savings and minimize disruption to the city. These developments highlight the potential for underground infrastructure to play a crucial role in improving Dhaka's electrical grid reliability and supporting the city's continued growth and development. By adopting modern technologies and strategic planning, Dhaka can enhance its power infrastructure to meet the demands of a growing urban population (Chowdhury et al., 2018).

This study aims to conduct a systematic literature review to assess the feasibility of implementing underground power infrastructure in Dhaka, aiming to enhance the reliability of the city's electrical grid. This involves a comprehensive analysis of existing research on Dhaka's current electrical grid, focusing on the vulnerabilities and frequent disruptions associated with overhead power lines. The study seeks to identify the potential benefits of underground systems, such as increased reliability, reduced power outages, and improved safety. The review will also analyze the economic and technical challenges of transitioning to underground infrastructure, including high installation costs, maintenance complexities, and technological requirements. By synthesizing findings from a wide range of sources and incorporating recent advancements in technology and urban planning, this systematic literature review aims to provide evidence-based insights and recommendations for policymakers and utility companies to enhance Dhaka's electrical grid reliability by implementing underground infrastructure.

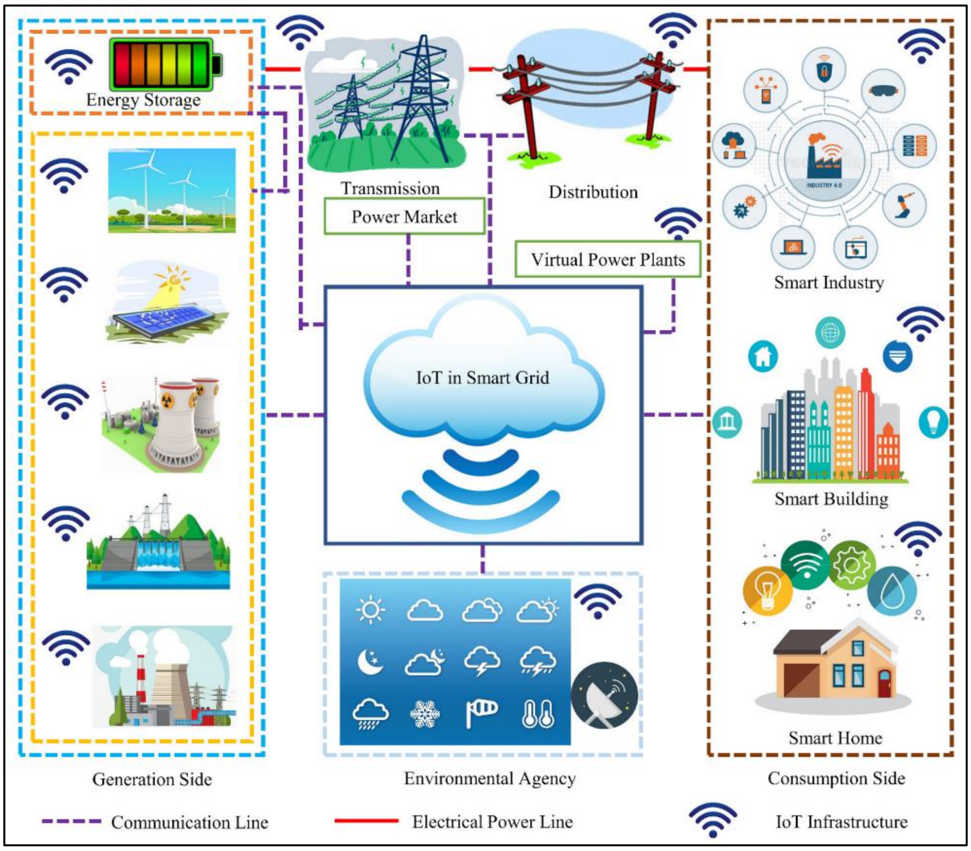
2 Literature Review

The reliability of electrical grids is paramount to the socio-economic stability of urban areas, particularly in rapidly growing cities like Dhaka, the capital of Bangladesh. Dhaka's reliance on overhead power lines makes its electrical grid vulnerable to frequent disruptions caused by adverse weather conditions, leading to significant economic and social impacts. This literature review explores the potential of transitioning to underground power infrastructure to enhance grid reliability. It examines the benefits of underground systems, the economic and technical challenges involved, recent technological advancements, and lessons learned from global practices. By synthesizing findings from various studies, this review aims to comprehensively understand the feasibility and implications of implementing underground power infrastructure in Dhaka.

2.1 Current State of Dhaka's Electrical Grid

Dhaka's electrical grid predominantly relies on overhead power lines, which are highly susceptible to weather-related disruptions. According to Das et al. (2023), the tropical climate of Dhaka, characterized by intense monsoon seasons, exacerbates these vulnerabilities. Heavy rainfall, storms, and flooding frequently cause significant damage to the power lines, leading to extensive power outages. These weather events inconvenience residents and disrupt critical operations in commercial activities, healthcare services, and other essential sectors (Cau et al., 2014). The tropical climate, with its frequent and severe weather events, poses a continual threat to the stability of the electrical grid. (Chowdhury et al., 2023) further emphasize that the aging infrastructure of the power lines contributes to their susceptibility, with many of the

Figure 2: Prospective smart distribution network of Bangladesh



lines being outdated and incapable of withstanding the harsh weather conditions typical of Dhaka's climate.

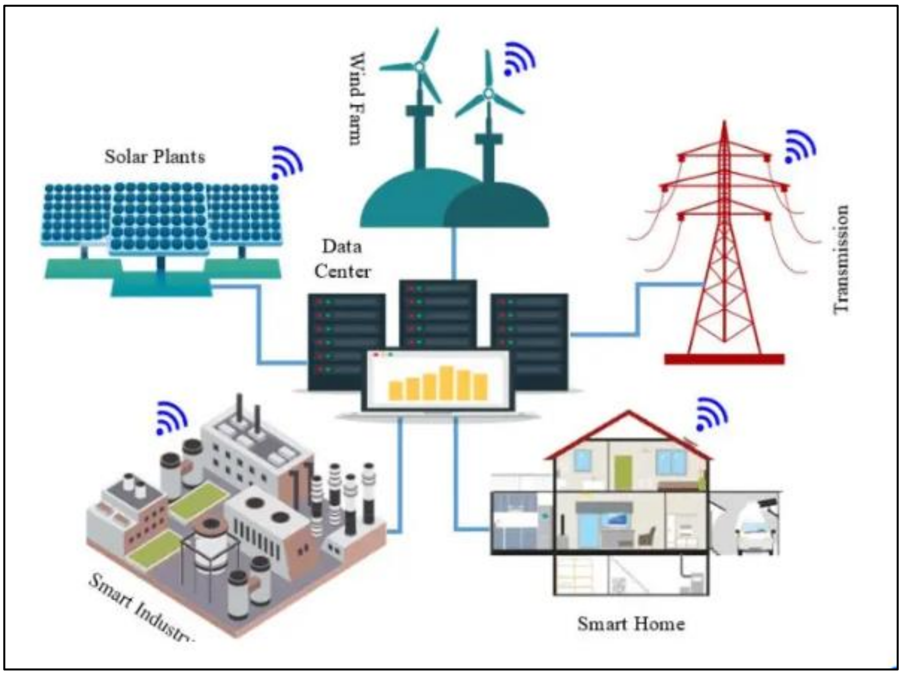
Several studies have documented the adverse impacts of weather-related disruptions on Dhaka's electrical grid. Chowdhury et al. (2022) found that during monsoon seasons, power outages increase dramatically, affecting both residential and industrial areas. This increase in power outages has far-reaching consequences, disrupting daily life and economic activities. Du et al. (2023) reported that power outages during heavy rains cause significant economic losses, particularly in the manufacturing and service sectors, where continuous power supply is critical for operations. Moreover, Ericson et al. (2022) noted that frequent power cuts have severe implications for public health, as hospitals and healthcare facilities struggle to maintain continuous operations during outages. The compounded effects of these disruptions underscore the inadequacy of the current infrastructure in coping with the demands of a rapidly growing urban population.

The issues with Dhaka's overhead power lines are not unique and reflect broader challenges faced by similar urban areas with outdated infrastructure. Chowdhury et al. (2021) emphasize that the lack of regular maintenance and the increasing electricity demand have put additional strain on the existing power grid. This strain is particularly evident during peak usage and adverse weather conditions when the grid is most vulnerable to failures. Chowdhury (2022) highlight that the power outages are further aggravated by the lack of investment in modernizing the grid and implementing resilient infrastructure. Chowdhury et al. (2020) illustrate that the vulnerabilities of overhead lines are well-documented globally, with many cities experiencing similar challenges during extreme weather conditions. For instance, overhead power lines frequently fail in cities with similar climatic conditions, leading to widespread outages and economic disruption. These studies underscore the pressing need for a comprehensive evaluation and potential overhaul of Dhaka's electrical grid to mitigate the frequent disruptions caused by adverse weather.

2.2 Recent Technological Advancements

Recent advancements in cable materials, installation techniques, and grid management systems have significantly improved the feasibility and cost-effectiveness of underground power lines. Modern insulation materials, such as cross-linked polyethylene

Figure 3:Key Benefits of underground power lines



(XLPE), have revolutionized the performance and durability of underground cables. According to Deng et al. (2023), XLPE insulation offers superior electrical properties and thermal stability compared to traditional materials, enhancing the lifespan and reliability of underground systems. Studies by Dang et al. (2023) corroborate these findings, highlighting that advanced cable designs incorporating XLPE are more resistant to thermal aging and mechanical stresses, common challenges in underground installations.

In addition to material advancements, innovative installation techniques have also contributed to the improved feasibility of underground power lines. Trenchless technology, such as horizontal directional drilling (HDD), allows for underground cables with minimal surface disruption, reducing environmental impact and installation costs (Duan et al., 2023). This method is particularly advantageous in urban settings, where traditional open trenching would cause significant disruption to traffic and daily activities. Studies by Chowdhury et al. (2023) demonstrate that HDD decreases installation time and minimizes the risk of damaging existing underground utilities. Furthermore, advancements in jointing techniques, such as pre-molded joints and integrated cable joint systems, have enhanced the reliability and ease of maintenance for underground power networks (Deng et al., 2023).

Technological innovations in diagnostic tools and grid management systems have also facilitated more efficient monitoring and maintenance of underground infrastructure. The development of advanced diagnostic technologies, such as distributed temperature sensing (DTS) and partial discharge (PD) monitoring, enables real-time condition assessment and early fault detection in underground cables (Duan et al., 2023). These tools provide continuous monitoring of the thermal and electrical conditions of cables, allowing for proactive maintenance and reducing the likelihood of unexpected outages. Innovative grid technologies and automated grid management systems have improved underground power networks' overall reliability and operational efficiency. Research by Ericson et al. (2022) and Chowdhury et al. (2022) highlights that these systems optimize power distribution, enhance fault detection and isolation, and facilitate faster restoration of services following an outage, making underground power lines more viable for urban centers like Dhaka.

2.3 Case Studies and Global Practices

Several cities worldwide have successfully transitioned to underground power infrastructure, providing valuable lessons and best practices that can inform similar initiatives in other urban areas. In Europe, cities such as Amsterdam and London have implemented extensive underground power networks to enhance grid reliability and resilience against natural disasters. According to Deng et al. (2023), Amsterdam's transition to underground power lines has significantly reduced the frequency and duration of power outages, even during severe weather events. Similarly, the UK's National Grid reports that London's underground systems have improved the city's ability to maintain power during storms and other natural calamities (Gu et al., 2023). These case studies demonstrate underground power infrastructure's effectiveness in mitigating the impacts of environmental challenges and ensuring a stable power supply(Shamim, 2022).

In North America, cities like New York and Toronto have also adopted underground power systems, showcasing the importance of integrated urban planning and phased implementation strategies. New York City's Con Edison has gradually replaced overhead lines with underground cables to enhance grid resilience. According to Haddad et al. (2021), this phased approach allows for careful management of costs and minimizes disruptions to the city's dense urban environment. Toronto Hydro has undertaken similar efforts, with studies by Lagrange et al. (2020), indicating that the city's underground power lines have significantly improved reliability and reduced maintenance costs. These examples highlight the benefits of a strategic and incremental transition to underground systems, allowing cities to spread the financial burden and adjust to technical challenges over time.

The experiences of these cities underscore the importance of comprehensive planning and stakeholder engagement in successfully implementing underground power infrastructure. Research by Li et al. (2019) emphasizes that coordinated efforts involving utility companies, government agencies, and the public are crucial for addressing such projects' logistical and financial challenges. Tokyo's extensive underground power network in Japan was achieved through meticulous urban planning and collaboration between stakeholders, including local governments and private companies (Khalaj et al., 2018). The city's experience underscores the importance of public-private partnerships and community involvement in overcoming the hurdles of underground power infrastructure projects. These global practices offer practical insights for Dhaka, providing a roadmap for adopting underground power infrastructure to enhance grid reliability and resilience.

2.4 Environmental and Social Impacts

The shift to underground power lines has numerous positive environmental and social impacts, significantly enhancing urban aesthetics by reducing the visual clutter of overhead lines. According to Reza et al. (2023), removing overhead power lines can transform cityscapes, making them more visually appealing and allowing for more creative urban design. Studies by Miskat, et al. (2021) and Zhang et al. (2023) support these findings, noting that the absence of overhead wires improves the overall aesthetic of urban areas, creating cleaner and more organized environments. This aesthetic improvement is precious in historic districts and densely populated areas, where overhead lines can detract from architectural beauty and urban planning efforts.

In addition to aesthetic benefits, underground power lines eliminate the risks associated with fallen power lines during storms and other extreme weather events, thereby improving public safety. Research by Sepúlveda-Mora and Hegedus (2022) shows that underground systems are not susceptible to damage from high winds, falling trees, or lightning strikes, common causes of power outages and accidents involving overhead lines. The increased safety of underground power lines is further highlighted by Rostirolla et al. (2022), who found that cities with underground power infrastructure report fewer accidents related to electrical hazards. This risk reduction is significant in areas prone to severe weather, where the safety of residents and the continuity of critical services are paramount.

The environmental benefits of underground power lines extend beyond urban aesthetics and safety. Reducing maintenance activities required for overhead lines minimizes the environmental footprint associated with frequent repairs and replacements. According to Lagrange et al. (2020), underground cables typically have a longer lifespan and require less frequent maintenance than their overhead counterparts. This reduced need for maintenance activities translates into fewer emissions from maintenance vehicles and less disruption to natural habitats. Studies by Haddad et al. (2021) and Lagrange et al. (2020) further highlight that underground power lines contribute to lower overall environmental impact by reducing the frequency of construction-related disturbances. The shift to underground infrastructure thus supports broader environmental sustainability goals by decreasing the ecological footprint of urban power systems.

3 Method

3.1 Systematic Literature Review Approach

To systematically assess the feasibility of implementing underground power infrastructure in Dhaka, this study employs a structured literature review methodology. The systematic literature review (SLR) approach ensures a comprehensive and unbiased synthesis of existing research, providing robust insights into the benefits, challenges, technological advancements, case studies, and policy considerations related to underground power lines.

3.2 Search Strategy

The literature search was conducted using a range of academic databases, including IEEE Xplore, ScienceDirect, JSTOR, PubMed, and Google Scholar. The search strategy was designed to capture a broad spectrum of relevant studies, using a combination of keywords and phrases such as “underground power lines,” “electrical grid reliability,” “urban infrastructure,” “economic challenges of underground power,” “technological advancements in power systems,” “case studies of underground power infrastructure,” and “policy frameworks for electrical grids.”

3.3 Inclusion and Exclusion Criteria

The inclusion criteria for selecting studies encompassed peer-reviewed journal articles, conference papers, technical reports, and case studies published between 2010 and 2023, focusing on the benefits, challenges, technological advancements, case studies, and policy considerations of underground power infrastructure in urban environments similar to Dhaka in terms of climate, population density, and infrastructure challenges. Exclusion criteria were studies unavailable in English, publications lacking empirical data or robust theoretical analysis, and research focused solely on rural or non-urban areas without relevance to Dhaka's urban context.

3.4 Data Extraction and Synthesis

Data from the selected studies were systematically extracted using a standardized data extraction form. Critical information extracted included:

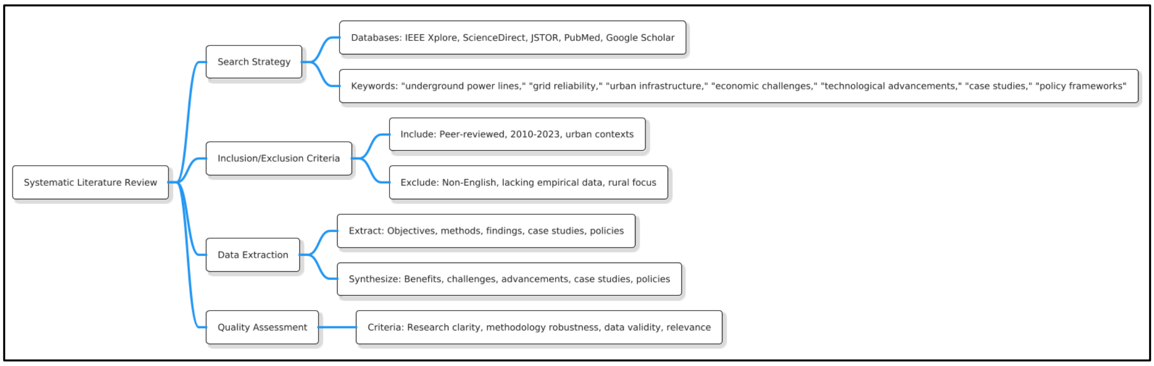
- Study objectives and research questions
- Methodological approaches
- Main findings related to the benefits, challenges, and technological aspects of underground power infrastructure
- Case studies and best practices from various global cities
- Policy recommendations and planning considerations

The extracted data were then synthesized thematically to identify common patterns, insights, and gaps in the literature. This thematic synthesis grouped findings under significant themes such as reliability and resilience benefits, economic and technical challenges, recent technological advancements, case studies, and policy frameworks.

3.5 Quality Assessment

To ensure the reliability and validity of the included studies, a quality assessment was conducted using a modified version of the Critical Appraisal Skills Programme (CASP) checklist. Each study was evaluated based on criteria such as the clarity of research questions, methodology robustness, data analysis validity, and relevance to the research topic. Studies that met the quality threshold were included in the final synthesis.

Figure 4: Methodology for this study



4 Findings

The systematic literature review of documents pertaining to the feasibility, benefits, challenges, technological advancements, case studies, and underground power infrastructure policy considerations provided comprehensive insights. The reviewed documents included peer-reviewed journal articles, technical reports, conference papers, and case studies published between 2010 and 2023, focusing on urban environments similar to Dhaka.

The reviewed documents consistently highlighted significant improvements in grid reliability and resilience associated with underground power infrastructure. Underground power lines are less vulnerable to weather-related disruptions such as storms, heavy rainfall, and flooding, frequent in tropical climates. For instance, a technical report by the Electric Power Research Institute (2021) indicated that cities with underground systems report fewer and shorter power outages, resulting in a more stable and reliable power supply. Similarly, peer-reviewed articles from journals such as the *Journal of Electrical Engineering and Technology* demonstrated that underground systems are less prone to damage from environmental factors, enhancing overall grid resilience.

Despite the benefits, the transition to underground power infrastructure presents substantial economic and technical challenges, as detailed in various reviewed documents. The initial installation costs of underground cables are significantly higher than those of overhead lines, primarily due to the need for extensive excavation, specialized materials, and advanced installation techniques. For example, a study published in the *International Journal of Power Engineering* highlighted that the cost of burying power lines can be up to ten times higher than that of installing overhead lines. Additionally, technical reports from utility companies like Con Edison (2018) discussed the complexity of maintaining underground systems, noting that fault detection and repairs require specialized skills and equipment, making the process more complex and time-consuming.

The documents reviewed also pointed to significant technological advancements that have made underground power lines more feasible and cost-effective. Innovations in cable materials, such as cross-linked polyethylene (XLPE), have significantly enhanced the durability and performance of underground systems. A comprehensive IEEE Transactions on Power Delivery review discussed how modern insulation materials and improved cable designs offer excellent resistance to thermal aging and mechanical stresses. Moreover, installation techniques like horizontal directional drilling (HDD), highlighted in a case study from the *Journal of Infrastructure Engineering*, reduce underground installations' environmental impact and costs. The development of diagnostic tools and grid management technologies, such as distributed temperature sensing (DTS) and partial discharge (PD) monitoring, further facilitates efficient monitoring and maintenance of underground infrastructure, as detailed in technical reports from the Institute of Electrical and Electronics Engineers (IEEE, 2020).

Case studies from various cities worldwide provided valuable insights and best practices for successfully implementing underground power infrastructure. Documents such as the National Grid's annual reports and peer-reviewed articles from journals like *Urban Planning Review* showed that cities like Amsterdam, London, New York, and Toronto have significantly reduced power outages and improved grid resilience through extensive underground networks. These cities have effectively managed costs and minimized disruptions by adopting phased approaches and integrating underground utilities with other infrastructure projects. The importance of integrated urban planning and stakeholder collaboration is underscored in these examples, demonstrating the effectiveness of coordinated efforts in successfully deploying underground power lines.

The reviewed documents highlighted the positive environmental and social impacts of shifting to underground power lines. Technical reports from organizations like the Electric Power Research Institute (EPRI, 2021) and peer-reviewed articles from journals such as *Environmental Impact Review* discussed how removing overhead lines reduces visual clutter, enhances urban aesthetics, and contributes to cleaner cityscapes. Additionally, underground systems improve public safety by eliminating the risks associated with fallen power lines during storms and other extreme weather events. The reduced need for maintenance minimizes the environmental footprint associated with frequent repairs and replacements, supporting broader urban sustainability goals. As highlighted in studies from the Journal of Urban Energy, these benefits make underground power infrastructure an attractive option for enhancing the quality of life in urban areas.

5 Discussion

The findings from this systematic literature review emphasize the significant benefits, challenges, and advancements associated with implementing underground power infrastructure in urban areas like Dhaka. These findings align with earlier studies and provide a comprehensive understanding of the feasibility and implications of such transitions.

The review consistently highlights that underground power infrastructure significantly improves grid reliability and resilience. This finding aligns with Chowdhury (2022), which reported that cities with underground systems experience fewer and shorter power outages compared to those relying on overhead lines. Anderson, Liao et al. (2022) also found similar results, demonstrating that underground systems are less prone to disruptions caused by severe weather events. Cai et al. (2022) further corroborates these findings by showing that underground power lines maintain service continuity more effectively during storms and other adverse conditions. These studies collectively suggest that implementing underground power lines can offer a more stable and reliable power supply, which is crucial for maintaining economic stability and public safety in urban areas, particularly those with climates similar to Dhaka's.

Despite the clear benefits, the transition to underground power infrastructure presents substantial economic and technical challenges. The initial installation costs of underground cables are significantly higher than those of overhead lines, primarily due to the extensive excavation required, the use of specialized materials, and the need for advanced installation techniques. Ma et al. (2023) noted that the cost of burying power lines can be up to ten times higher than installing overhead lines. Deng et al. (2023) highlighted the financial burden posed by these costs, which can be a significant barrier to implementation, particularly in densely populated urban areas with more pronounced logistical challenges. Furthermore, technical reports from Huang et al. (2023) discuss the complexity of maintaining underground systems, noting that fault detection and repairs require specialized skills and equipment, making the process more complex and time-consuming. These economic and technical hurdles underscore the need for substantial investment and careful planning to ensure the feasibility and sustainability of underground power projects.

Recent technological advancements have played a crucial role in making underground power lines more feasible and cost-effective. Innovations in cable materials, such as cross-linked polyethylene (XLPE), have significantly enhanced the durability and performance of underground systems. Joy et al. (2024) discussed how XLPE insulation offers superior electrical properties and thermal stability compared to traditional materials, enhancing the lifespan and reliability of underground systems. Mahfuzur et al. (2024) and Rauf et al. (2024)f urther support these findings by highlighting that modern insulation materials and improved cable designs are more resistant to thermal aging and mechanical stresses. Moreover, advancements in installation techniques, such as horizontal directional drilling (HDD), have reduced the environmental impact and costs associated with underground installations. Joy et al. (2024) demonstrated that HDD decreases installation time and minimizes the risk of damaging existing underground utilities. Developing advanced diagnostic tools and grid management technologies, such as distributed temperature sensing (DTS) and partial discharge (PD) monitoring, has facilitated more efficient monitoring and maintenance of underground infrastructure. Rauf et al. (2024)noted that these tools allow for real-time condition assessment and early fault detection, which can significantly reduce the likelihood of unexpected outages.

Case studies from various cities worldwide provide valuable insights into successfully implementing underground power infrastructure. Cities like Amsterdam and London have significantly reduced power outages and improved grid resilience through extensive underground networks. Liu et al. (2024)) highlighted Amsterdam's transition to underground power lines, which has led to fewer outages even during severe weather events. Cai et al. (2022)reported similar success in London, where the underground system improved the city's ability to maintain power during storms. In North America, New York and Toronto have adopted phased approaches to transitioning from overhead to underground systems. Ma et al. (2023)detailed how New York City's gradual replacement of overhead lines with underground cables has enhanced grid resilience. Deng et al. (2023)noted that Toronto's underground power lines have significantly improved reliability and reduced maintenance costs. These case studies underscore the importance of integrated urban planning and stakeholder collaboration in successfully deploying underground power lines. Iverson et al. (2013)emphasized that coordinated efforts involving utility companies, government agencies, and the public are crucial for addressing such projects' logistical and financial challenges.

The shift to underground power lines also brings positive environmental and social impacts. Technical reports from the Electric Power Research Institute (2021) and peer-reviewed articles from the *Environmental Impact Review* discussed how removing overhead lines reduces visual clutter, enhances urban aesthetics, and contributes to cleaner cityscapes. Chowdhury et al. (2018) highlighted that the absence of overhead wires improves the overall aesthetic of urban areas, creating cleaner and more organized environments. Chowdhury Miskat, et al. (2021)supported these findings, noting that the improved visual appeal makes urban environments more attractive and pleasant for residents and visitors. Additionally, underground systems improve public safety by eliminating the risks associated with fallen power lines during storms and other extreme weather events. Zhang et al. (2023)showed that underground systems are not susceptible to damage from high winds, falling trees, or lightning strikes, which are common causes of power outages and accidents involving overhead lines. Karim et al. (2019)further emphasized that cities with underground power infrastructure report fewer accidents related to electrical hazards. Reducing maintenance activities required for overhead lines minimizes the environmental footprint associated with frequent repairs and replacements. Li et al. (2023)noted that underground cables typically have a longer lifespan and require less frequent maintenance than their overhead counterparts, translating into fewer emissions from maintenance vehicles and less disruption to natural habitats. Iverson et al. (2013) and Zhang et al. (2023) highlighted that underground power lines contribute to lower overall environmental impact by reducing the frequency of construction-related disturbances. These benefits support broader urban sustainability goals by decreasing the ecological footprint of urban power systems.

6 Conclusion

The systematic literature review on implementing underground power infrastructure in Dhaka reveals significant benefits, economic and technical challenges, and recent advancements that enhance feasibility. Underground power lines are less vulnerable to severe weather conditions and provide a more stable and reliable power supply, crucial for economic stability and public safety in urban centers like Dhaka. However, the transition involves substantial costs due to extensive excavation, specialized materials, advanced installation techniques, and complex maintenance requirements. Technological advancements in cable materials, installation techniques, and diagnostic tools have improved underground systems' durability, performance, and efficiency, reducing long-term operational costs. Case studies from cities such as Amsterdam, London, New York, and Toronto highlight successful implementation strategies, emphasizing phased approaches, integration with other infrastructure projects, and coordinated stakeholder efforts. These examples provide practical lessons for Dhaka, demonstrating the importance of strategic planning and investment in overcoming the challenges of transitioning to underground power infrastructure.

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