Chapter 14
Optimizing the Grid Edge Distributed Energy Resources and Cloud Integration

Yugal Mishra
School of Computer Engineering, KIIT University (Deemed), Bhubaneswar, India

Devansh Mishra
School of Computer Engineering, KIIT University (Deemed), Bhubaneswar, India

Vatsal Saxena
School of Computer Engineering, KIIT University (Deemed), Bhubaneswar, India

Addya Tiwari
School of Computer Engineering, KIIT University (Deemed), Bhubaneswar, India

Hitesh Mohapatra
https://orcid.org/0000-0001-8100-4860
S School of Computer Engineering, KIIT University (Deemed), Bhubaneswar, India

ABSTRACT

The integration of smart grids and cloud computing stands as a pivotal frontier in modern energy management, offering both opportunities and challenges. This paper delas with the complexities of this convergence, exploring how smart grids utilize advanced technologies to optimize operations, while cloud computing provides the computational power for data analysis. However, this integration presents hurdles, including technical and regulatory concerns. This study focuses into the implications of merging smart grids with cloud computing on energy efficiency and grid reliability. Findings reveal potential benefits such as enhanced grid flexibility and consumer engagement, alongside challenges like data privacy and cybersecurity. Recognizing these implications is essential for guiding future research and policy initiatives aimed at fostering a resilient and sustainable energy landscape. By capitalizing on the synergy between smart grids and cloud computing, stakeholders can drive innovation and unlock new avenues for progress in the energy sector.

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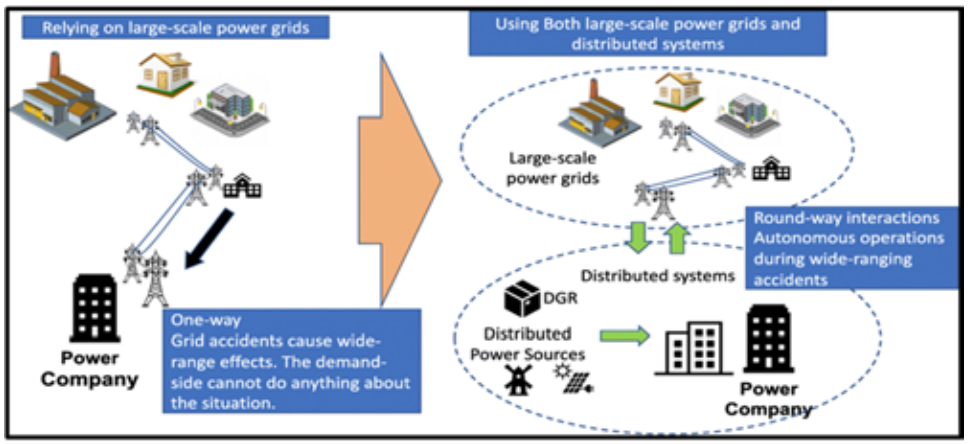
1. INTRODUCTION

The traditional electricity grid, characterized by centralized generation and one-way power flow, faces increasing challenges in the 21st century, including rising energy demand, growing integration of renewable sources, and climate change (Mohsenian-Rad & Wong, 2010). This necessitates a paradigm shift towards a more intelligent and flexible grid system. Smart grids, empowered by digital technologies and advanced communication networks, emerge as a promising solution to address these challenges (Mohsenian-Rad & Wong, 2010).

Figure 1. Comparison of the organizations of traditional power grid and smart grid



At the heart of smart grids lies the integration of cloud computing, providing a scalable and cost-effective platform for data management, analytics, and real-time grid operations (Yan & Li, 2014). The vast computational power and storage capacity of cloud platforms enable smart grids to efficiently handle the massive volume of data generated by sensors, meters, and other intelligent devices deployed across the grid (Yan & Li, 2014). This data deluge, often referred to as big data, holds immense potential for optimizing grid operations, enhancing reliability, and promoting efficient energy distribution (Ghobakhloo et al., 2014). By leveraging cloud-based analytics, smart grids can gain valuable insights into energy consumption patterns, predict equipment failures, and forecast future demand (Ghobakhloo et al., 2014). This enables proactive maintenance, targeted interventions, and dynamic pricing models that incentivize energy conservation during peak hours. Furthermore, cloud-based platforms facilitate the development of distributed intelligence and real-time control mechanisms, empowering smart grids to adapt to changing conditions and optimize energy flows across the network (Ghobakhloo et al., 2014). One significant advantage of cloud-based solutions for smart grids is their scalability. Traditional grid infrastructure often struggles to accommodate the increasing volume of data generated by smart devices and sensors. However, cloud platforms offer virtually limitless scalability, allowing utilities to expand their data processing and storage capabilities as needed (Mohapatra, 2021). Moreover, cloud computing can significantly reduce the upfront infrastructure costs associated with deploying smart grid technologies. By shifting from on-premises data centers to cloud-based services, utilities can avoid the need for costly hardware investments and instead pay for computing resources on a usage basis (Goudarzi et al.,