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Future Trends and Opportunities in Structured Electrical Power Systems

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Abstract: The power systems industry is experiencing a paradigm shift, driven by rapid technological advancements, decarbonization initiatives, and digital transformation. As nations move toward achieving net-zero emissions, the integration of renewable energy sources such as solar and wind has become vital. The future of power systems is increasingly defined by decentralized generation, artificial intelligence, smart grids, and digital control technologies. This transformation is also enhanced by innovations in energy storage, electric mobility, and automation, which are enabling more flexible and reliable networks. The combination of these developments is leading to a more resilient, efficient, and sustainable global energy ecosystem. The evolution of smart grids and IoT-based monitoring is reshaping system operations, while AI enables predictive maintenance and real-time optimization. Furthermore, energy storage technologies play a crucial role in stabilizing renewable energy generation and ensuring reliability. This paper explores these future trends and highlights the immense opportunities in power systems engineering for innovation, employment, and sustainability. The synergy between renewable integration, energy storage, and intelligent control forms the foundation of the next-generation energy landscape, driving global progress toward clean and inclusive energy for all.

Keywords: *Power Systems, Highvoltage DC Transmission Systems, Multi Teminal DC Systems, Voltage Sourcs Converters.*

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I. INTRODUCTION

The global energy landscape is undergoing an unprecedented transformation, influenced by environmental awareness, technological innovation, and policy-driven transitions. Power systems—once centralized, fossil-fuel-based, and rigid—are now evolving into decentralized, flexible, and intelligent networks. This evolution stems from the urgent need to reduce carbon emissions, optimize energy efficiency, and enhance system reliability. As emerging economies continue to industrialize and urbanize, energy demand is expected to rise significantly, necessitating cleaner and smarter solutions for generation, transmission, and distribution[1]-[2].

Traditionally, power systems operated under centralized control, with generation plants delivering electricity through long transmission lines to end-users. However, this model is becoming obsolete in the context of modern requirements. The advent of renewable energy resources, distributed energy systems, and advanced automation has introduced new complexities and opportunities. Smart grids enhanced with sensors, control systems, and communication network senable dynamic management of generation and consumption patterns, improving both efficiency and sustainability[3]-[4].

The shift toward renewables presents both opportunities and challenges. Solar and wind power, while clean and abundant, introduce intermittency issues that can destabilize conventional grids. To address this, energy storage systems and advanced forecasting algorithms are increasingly employed. Simultaneously, digitalization plays a central role by allowing operators to leverage big data analytics, machine learning, and IoT technologies for real-time decision-making. These tools enable the grid to respond adaptively to fluctuations in supply and demand[5]-[6].

Ultimately, the modernization of power systems reflects a global pursuit of sustainable development. It aims to provide affordable, reliable, and clean electricity for all while mitigating environmental impacts. This paper delves into emerging technologies and trends shaping the future of power systems and examines the challenges and opportunities they

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bring to engineers, policymakers, and stakeholders worldwide[7]-[8].

The global electrical power system is undergoing a revolutionary transformation driven by the twin imperatives of sustainability and technological innovation. Traditional centralized grids, once dominated by large fossil-fuel-based generation units, are evolving into complex, intelligent, and decentralized networks integrating renewable energy sources, digital controls, and advanced communication systems. This evolution is not merely a technical shift but a paradigm change that encompasses economic, environmental, and social dimensions. The growing energy demand due to industrialization, urbanization, and digital connectivity has placed enormous pressure on conventional energy infrastructure. At the same time, the urgent need to mitigate climate change has accelerated the global transition toward low-carbon energy systems. Consequently, modern electrical power systems are being redesigned to incorporate renewable generation, electric mobility, smart grids, and energy storage technologies. These advancements are reshaping how electricity is generated, transmitted, distributed, and utilized. As a result, the power sector is becoming more flexible, efficient, and resilient, setting the foundation for sustainable development in the coming decades. The convergence of power electronics, artificial intelligence, and communication technologies is further enabling a dynamic and intelligent electricity ecosystem, capable of responding in real time to variations in generation and demand[9]-[10].

One of the most prominent trends shaping the future of electrical power systems is the large-scale integration of renewable energy sources such as solar, wind, hydro, and biomass. The increasing penetration of distributed energy resources (DERs) has led to a transition from centralized generation models to decentralized architectures, where small-scale power producers contribute actively to the grid. Photovoltaic (PV) systems and wind farms are now among the fastest-growing segments of global energy capacity additions. This shift brings several opportunities, including enhanced energy access in remote regions, reduced transmission losses, and improved energy independence. However, it also introduces significant technical challenges such as grid stability, intermittency management, and power quality control. To overcome these challenges, researchers and utilities are focusing on developing flexible grid infrastructures supported by advanced forecasting, demand-side management, and microgrid technologies. The evolution of smart inverters, power electronic converters, and hybrid renewable systems has further improved the controllability and reliability of renewable energy integration. Decentralized power systems, supported by microgrids and distributed generation, are enabling communities to produce and manage their energy locally, enhancing resilience against grid disturbances and natural disasters. This trend toward decentralization represents both a technological and social transformation, aligning the energy transition with the global goals of sustainability, inclusivity, and energy equity[11]-[12].

Digitalization has become the cornerstone of modern electrical power systems, transforming conventional grids into intelligent networks known as smart grids. Smart grids leverage advanced communication technologies, Internet of Things (IoT) devices, and data analytics to monitor, control, and optimize electricity flow in real time. They enable bidirectional power and information exchange between utilities and consumers, creating a more interactive and efficient energy environment. Artificial intelligence (AI) and machine learning (ML) algorithms are increasingly being employed for load forecasting, fault detection, predictive maintenance, and energy optimization. Through AI-based decision-making, grid operators can manage demand-response programs more effectively and ensure the efficient operation of renewable energy assets. The application of blockchain technology is also emerging as a game-changer in energy transactions, ensuring transparency and decentralization in peer-to-peer energy trading. Furthermore, digital twins of electrical assets are being developed to simulate real-time operations, enabling predictive analysis and risk mitigation. The synergy between digitalization, automation, and AI is driving a new era of reliability, security, and intelligence in power systems. As the grid becomes more data-driven, cybersecurity and privacy concerns are gaining prominence, leading to the development of robust protection frameworks to safeguard digital infrastructures[13]-[14].

The future of electrical power systems also depends heavily on advancements in energy storage technologies and the rapid adoption of electric mobility. Energy storage plays a pivotal role in addressing the intermittency issues of renewable energy sources and ensuring grid stability. Technologies such as lithium-ion batteries, flow batteries, supercapacitors, and emerging hydrogen-based storage systems are transforming how energy is stored, shifted, and utilized. Battery Energy Storage Systems (BESS) are increasingly being integrated with renewable plants and microgrids to provide frequency regulation, load balancing, and backup power. Meanwhile, the electrification of transportation through Electric Vehicles (EVs) introduces new dimensions to power system operation. EVs not only increase electricity demand but also offer opportunities for Vehicle-to-Grid (V2G) integration, where parked vehicles can supply energy back to the grid during peak hours. This concept promotes distributed storage and enhances grid flexibility. Power electronics, particularly converters and inverters, are critical in facilitating these transitions, ensuring efficient power conversion and control across various applications. Wide bandgap semiconductor devices such as SiC (Silicon Carbide) and GaN (Gallium Nitride) are enabling high-efficiency, compact, and reliable converter designs. These developments collectively support the vision of a sustainable, intelligent, and electrified future[15]-[16].

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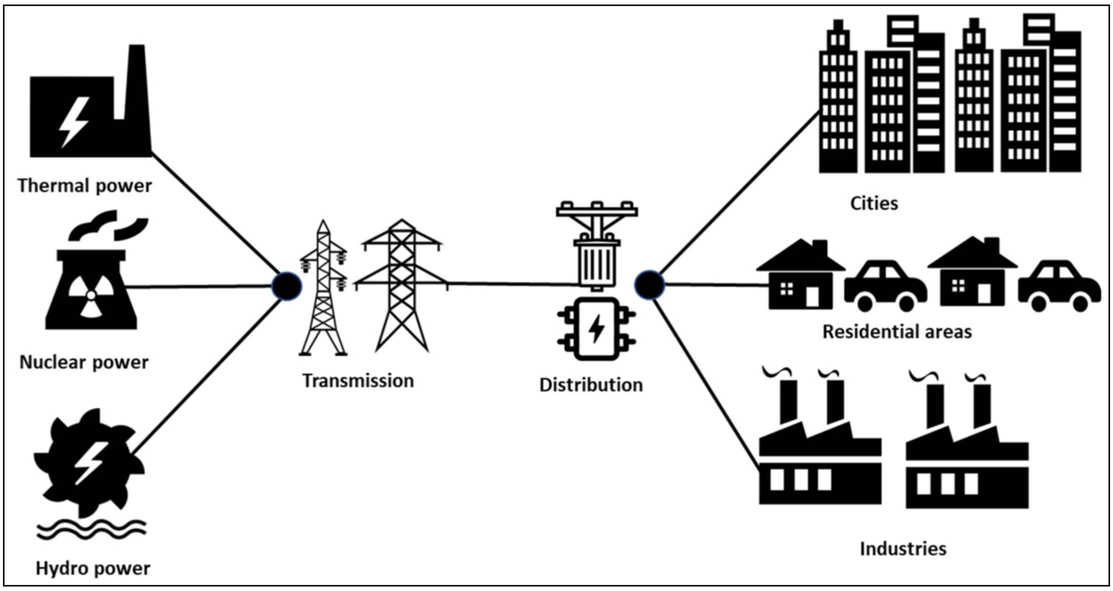

Fig 1. Traditional Thread of Power Systems

The emerging trends in electrical power systems present unprecedented opportunities for innovation, investment, and research. The global energy transition is fostering new business models, such as prosumer-based markets, virtual power plants, and energy-as-a-service (EaaS) frameworks. Moreover, the growing emphasis on energy sustainability and decarbonization is driving government policies, regulatory reforms, and international collaborations aimed at achieving net-zero emissions. Developing nations are particularly poised to benefit from these trends by leapfrogging to modern, decentralized, and renewable-based infrastructures without the constraints of legacy systems. Nevertheless, several challenges remain, including the need for massive infrastructure investments, standardization, and skilled workforce development. Ensuring system reliability, cybersecurity, and affordability in the face of rapid technological change is equally critical. Research in advanced power electronics, grid automation, and hybrid energy systems continues to open new frontiers for innovation. The future of electrical power systems will likely be characterized by high levels of automation, renewable dominance, and consumer participation. As the global community moves toward a more sustainable and digitally connected energy ecosystem, the integration of intelligent control, resilient infrastructure, and environmentally conscious technologies will define the next era of power system development. These transformations not only promise to deliver clean, reliable, and efficient energy but also to catalyze economic growth and environmental stewardship worldwide[17]-[18].

II. TECHNOLOGICAL INNOVATIONS IN POWER SYSTEMS

Technological advancement is the cornerstone of modern electrical power system evolution. Among the most transformative innovations are smart grids, Internet of Things (IoT) integration, artificial intelligence (AI)-based predictive analytics, advanced metering infrastructure (AMI), and renewable hybrid systems. Smart grids allow for dynamic two-way communication between utilities and consumers, ensuring real-time monitoring and adaptive control of electrical parameters. The deployment of synchro phasors and Phasor Measurement Units (PMUs) enables high-speed data acquisition, enhancing grid visibility and stability assessment[19].

AI and machine learning (ML) techniques are increasingly applied in load forecasting, power quality analysis, and fault diagnosis. For example, neural networks and fuzzy inference systems are used for adaptive control and fault-tolerant operations in distribution systems. Edge computing and cloud-based data analytics have further strengthened the decision-making capacity of utilities by processing vast amounts of data from sensors and IoT devices in real time[20].

In power generation, technological innovation is reshaping the design of renewable energy plants. Advanced Maximum Power Point Tracking (MPPT) algorithms optimize the performance of solar PV arrays, while aerodynamic blade design and power electronic converters have enhanced the efficiency of modern wind turbines. Similarly, HVDC (High Voltage Direct Current) and Flexible AC Transmission Systems (FACTS) have revolutionized power transmission, enabling long-distance, low-loss power transfer and improved voltage stability[21].

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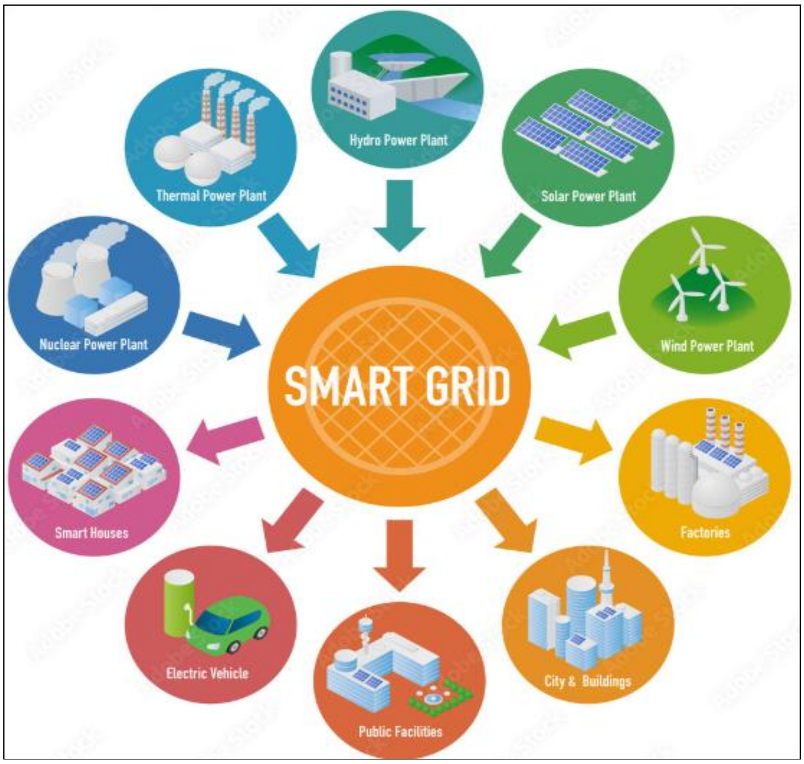

Fig 2.Technological Innovation in Power Systems

Emerging materials and devices, such as Silicon Carbide (SiC) and Gallium Nitride (GaN) semiconductors, are ushering in a new generation of converters and inverters with higher efficiency and compact design. These advancements not only improve system performance but also contribute to carbon footprint reduction. Overall, technological innovation is enabling the power system to evolve from a rigid infrastructure into a flexible, intelligent, and adaptive network[22].

III. CHALLENGES IN MODERN POWER SYSTEMS

Despite remarkable progress, several challenges hinder the seamless transformation of power systems. The foremost challenge is intermittency associated with renewable energy sources. Solar and wind energy generation are inherently variable, requiring robust forecasting and balancing mechanisms to maintain grid stability. Energy storage systems partially address this issue, but large-scale deployment remains constrained by cost, efficiency, and lifecycle limitations[23].

Another major challenge is grid reliability and security. As networks become more interconnected and data-driven, they become vulnerable to cyberattacks and communication failures. Cybersecurity is now a top priority in modern grid planning, with protocols being developed for intrusion detection, encryption, and resilience enhancement[24].

Regulatory and economic barriers also slow down innovation adoption. Many developing countries still operate legacy systems with outdated infrastructure, which makes modernization costly and complex. The lack of standardized protocols for interoperability between devices and platforms adds further complexity[25].

Environmental and social considerations present additional challenges. Large-scale renewable projects often face land-use conflicts, environmental impact concerns, and public resistance. Furthermore, the growing dependence on digital systems raises issues related to data privacy, automation ethics, and workforce adaptation[26].

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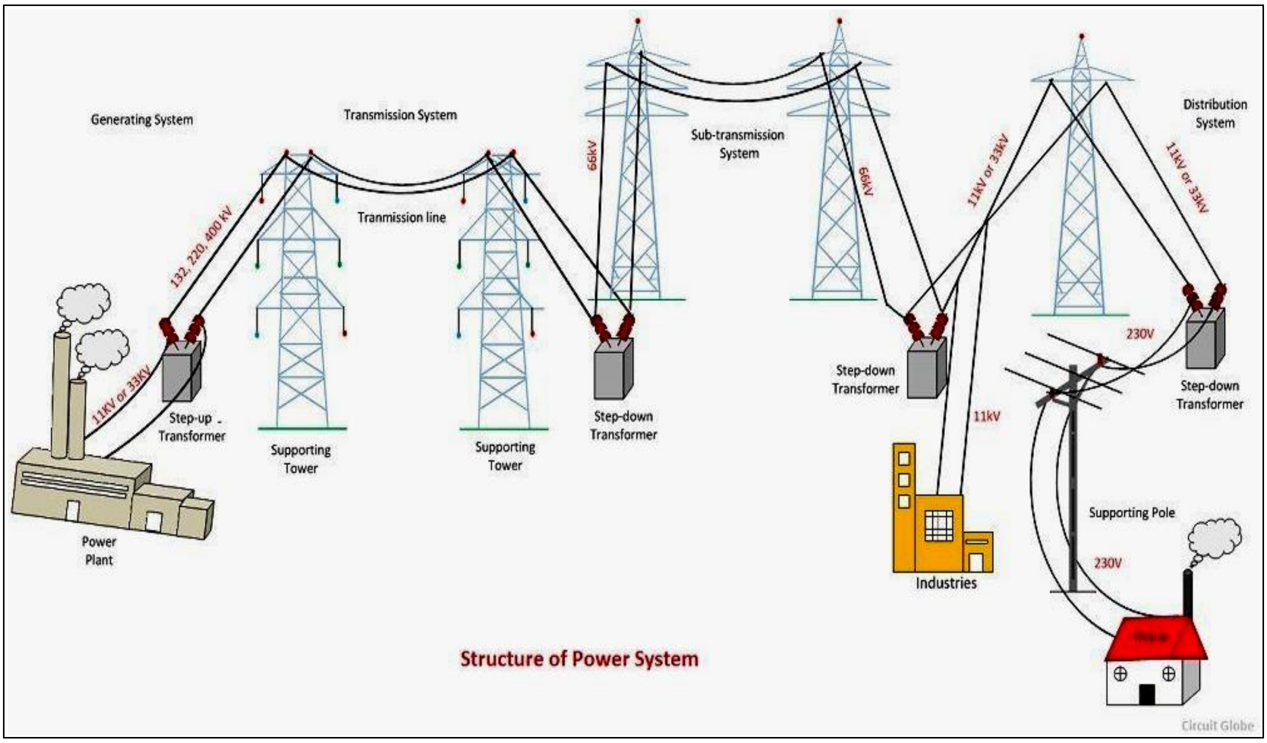

Fig 3. Structure of Power System

Therefore, integration of electric vehicles (EVs) presents both opportunity and operational complexity. The charging demand from EVs can cause local distribution network stress if not managed properly. Hence, smart charging infrastructure and vehicle-to-grid (V2G) coordination mechanisms are critical to ensuring balanced power flow. Addressing these challenges requires coordinated efforts between technology developers, utilities, regulators, and consumers[27].

IV. ENERGY STORAGE AND FLEXIBILITY

Energy storage and system flexibility form the cornerstone of the modern electrical power system transition toward sustainability, reliability, and resilience. As global power networks increasingly integrate renewable energy sources such as solar and wind, the inherent intermittency and variability of these sources pose significant challenges to maintaining grid balance and stability. Energy storage technologies address these challenges by enabling the capture of excess electricity during periods of low demand or high renewable generation and releasing it during periods of scarcity or peak consumption. This capability transforms the traditionally passive electrical grid into a dynamic and responsive system capable of self-regulation and real-time optimization. Flexibility, in this context, refers to the ability of the power system to adapt its generation, consumption, and network configuration to manage fluctuations in supply and demand effectively. Together, energy storage and flexibility technologies underpin the vision of a low-carbon, high-efficiency, and resilient energy ecosystem.

Among the various storage technologies, Battery Energy Storage Systems (BESS) have emerged as the most versatile and widely deployed solutions. Lithium-ion batteries dominate the current market due to their high energy density, efficiency, and fast response characteristics. These systems are being deployed at both utility-scale and distributed levels to perform functions such as frequency regulation, voltage support, peak shaving, and load shifting. The integration of BESS with renewable generation sources like solar photovoltaics (PV) and wind farms enables smoother power output, minimizing fluctuations and curtailment. Furthermore, advancements in control algorithms and power electronics allow for precise management of charging and discharging cycles, thereby extending the lifespan and performance of batteries. In addition to lithium-ion technology, alternative chemistries such as sodium-sulfur (NaS), redox flow, and solid-state batteries are gaining traction due to their scalability, safety, and potential for longer-duration storage. Flow batteries, in particular, offer independent scaling of power and energy capacity, making them ideal for grid-level applications that require multi-hour storage and high cycling capability.

Fig 4 Battery Energy Storage Systems

Beyond electrochemical solutions, several mechanical and thermal energy storage technologies play crucial roles in enhancing grid flexibility. Pumped Hydro Storage (PHS) remains the largest and most mature form of energy storage globally, accounting for over 90% of installed capacity. PHS utilizes the potential energy of water stored at elevation to generate electricity on demand, offering long discharge durations and high reliability. Similarly, Compressed Air Energy Storage (CAES) and flywheel systems provide mechanical means of balancing grid fluctuations, though they differ in response time and efficiency. Flywheels are particularly effective in frequency regulation due to their rapid response, whereas CAES systems are suited for bulk energy management over longer durations. Thermal Energy Storage (TES), which involves storing heat or cold for later use, is increasingly being employed in conjunction with concentrated solar power (CSP) plants and district heating systems. The integration of TES into power systems provides not only load flexibility but also opportunities for coupling the electricity sector with industrial and heating applications, fostering a more integrated energy ecosystem.

A key dimension of future power system flexibility lies in the synergy between energy storage and demand-side management. By integrating storage with smart grids, advanced metering infrastructure (AMI), and demand response (DR) mechanisms, utilities can coordinate consumption patterns in real time, aligning them with generation profiles. Consumers equipped with distributed storage units and rooftop solar systems can act as "prosumers," generating, storing, and exchanging energy with the grid. This decentralized approach not only enhances flexibility but also democratizes energy participation. Vehicle-to-Grid (V2G) technology exemplifies this concept, where electric vehicles (EVs) function as mobile energy storage units. During peak demand, EVs can discharge stored electricity back into the grid, while during off-peak hours, they recharge at lower costs. This bidirectional energy flow transforms transportation infrastructure into a critical component of power system flexibility. The large-scale adoption of EVs, coupled with intelligent charging strategies, can significantly stabilize grid operations and reduce dependency on conventional peaking plants.

V. ARTIFICIAL INTELLIGENCE AND IOT IN POWER SYSTEMS

The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) is transforming the traditional electrical power system into a smart, autonomous, and data-driven infrastructure. Together, these technologies are enabling predictive, adaptive, and self-healing capabilities that were previously unattainable within conventional grids. AI contributes intelligent decision-making and optimization algorithms, while IoT provides the sensing, communication, and connectivity layers necessary to collect and transmit real-time data from distributed assets. In modern power systems, the combination of AI and IoT—often referred to as AIoT (Artificial Intelligence of Things)—forms the foundation of the smart grid, which enhances system efficiency, reliability, and sustainability through automation and analytics. This transformation is essential to manage the increasing complexity arising from renewable energy integration, electric vehicle penetration, and the decentralization of generation and consumption[28].

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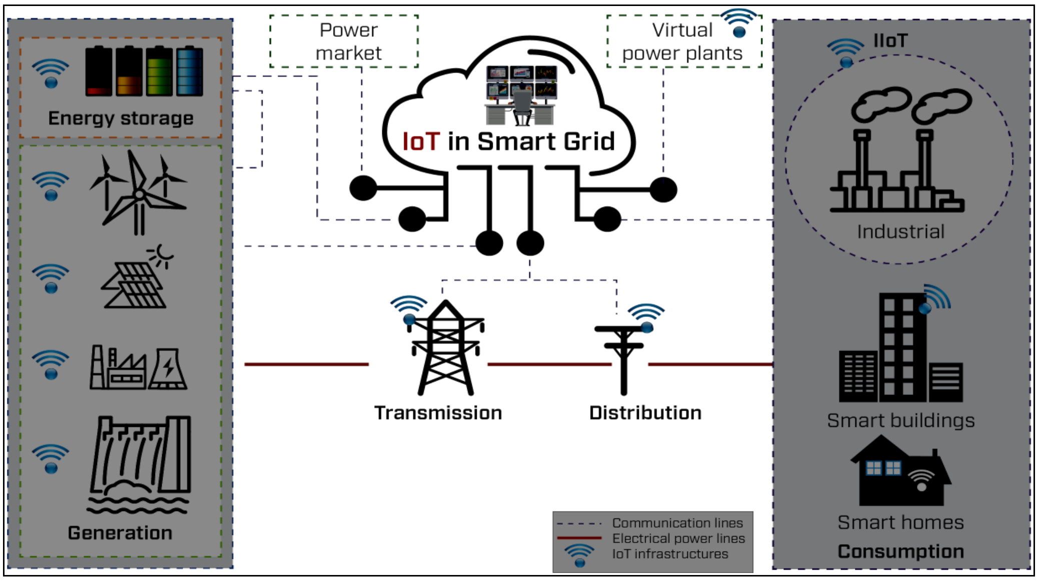

Fig 5. The Integration of Artificial Intelligence (AI) and the Internet of Things (IoT)

IoT technology plays a pivotal role in building situational awareness across all layers of the power system—generation, transmission, distribution, and consumption. Through the deployment of sensors, smart meters, and intelligent electronic devices (IEDs), IoT networks continuously gather data on voltage levels, frequency, power quality, and equipment health. These interconnected devices communicate through wireless and fiber-optic networks, providing grid operators with unprecedented visibility into system dynamics. The data collected forms the backbone for advanced AI analytics, which can detect anomalies, forecast demand, and optimize resource utilization. For instance, IoT-enabled smart meters facilitate real-time monitoring of household energy usage, allowing consumers to adjust consumption patterns in response to dynamic pricing signals. Similarly, substations equipped with IoT sensors can transmit asset condition data to centralized control centers, enabling predictive maintenance and reducing unexpected outages. The result is a responsive, efficient, and consumer-oriented power system that aligns with modern sustainability and reliability standards[29].

Artificial Intelligence enhances this connected infrastructure by introducing learning, prediction, and optimization capabilities. Machine Learning (ML) algorithms analyze large volumes of historical and real-time data to identify hidden patterns and correlations that human operators may overlook. In power generation, AI is used to optimize renewable energy forecasting by analyzing meteorological data, thereby improving grid balancing and reducing curtailment. In transmission systems, AI-driven tools are applied for dynamic line rating and fault location identification, ensuring efficient power flow and faster restoration following disturbances. Deep learning models have also proven effective in detecting incipient faults in transformers, circuit breakers, and cables through pattern recognition of vibration, acoustic, and thermal signatures. In distribution networks, fuzzy logic controllers and reinforcement learning algorithms enable adaptive voltage control and load management, optimizing reactive power flow and minimizing energy losses. Furthermore, AI assists in energy trading, market forecasting, and system planning by processing multi-dimensional datasets, supporting informed decision-making and long-term investment strategies[30].

One of the most transformative applications of AI and IoT in the power sector is the development of self-healing grids. These intelligent networks use real-time data from IoT sensors combined with AI-based analytics to detect, isolate, and restore faults automatically without human intervention. When an outage or abnormal condition occurs, the system reconfigures itself to minimize service disruption and maintain stability. Such resilience is especially critical in renewable-dominant grids, where fluctuations are more frequent and traditional control systems may be inadequate. Another emerging area is AI-enabled demand response (DR), where machine learning models analyze user behavior and consumption trends to adjust demand dynamically. This coordination between consumers, utilities, and distributed generators improves load balancing, enhances flexibility, and reduces reliance on peaking power plants.

VI. RENEWABLE ENERGY INTEGRATION

The integration of renewable energy sources (RES) such as solar, wind, hydro, biomass, and geothermal into electrical power systems represents one of the most significant transformations in the history of energy engineering. Driven by the dual imperatives of environmental sustainability and energy security, renewable integration is reshaping how electricity is generated, transmitted, distributed, and consumed. Unlike conventional fossil-fuel-based generation, which provides controllable and dispatchable power, renewable sources are inherently variable and intermittent. This variability presents both opportunities and challenges for grid operators, policymakers, and researchers. On one hand, renewable integration reduces carbon emissions, enhances energy independence, and diversifies the energy mix; on the other, it demands the modernization of grid infrastructure, the implementation of advanced control technologies, and the development of new operational strategies to ensure reliability and stability. As the world accelerates toward achieving net-zero carbon targets, renewable energy integration has become not just an environmental necessity but a strategic pillar of modern power system design and operation.

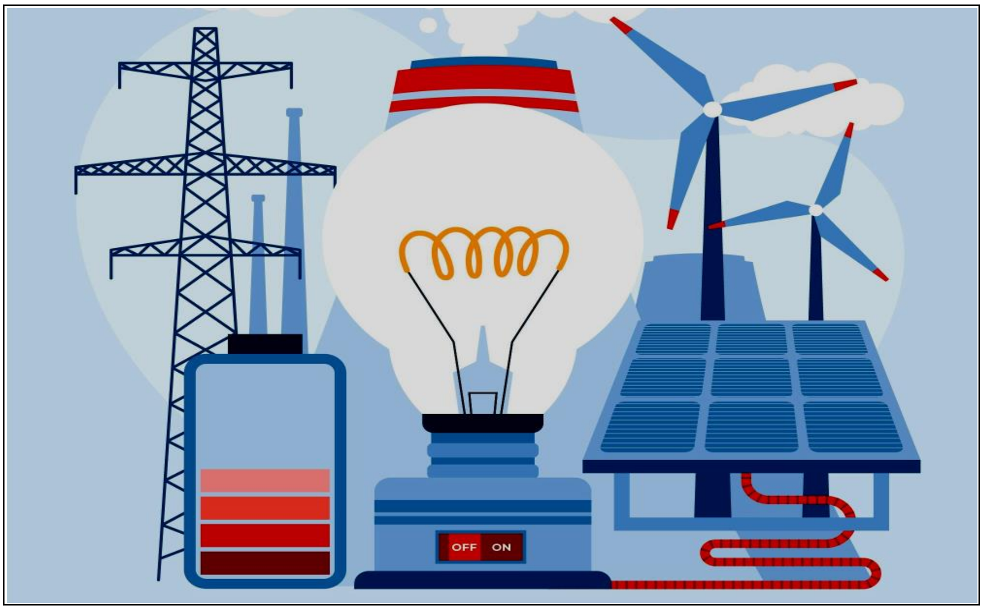

Fig .6 Renewable Energy Integration

Solar and wind energy are the most rapidly expanding renewable technologies worldwide, supported by dramatic reductions in cost, technological advancement, and favorable policy mechanisms. Solar Photovoltaic (PV) systems, for instance, have evolved from small rooftop installations to massive utility-scale solar farms capable of generating hundreds of megawatts. The modularity of PV systems allows for flexible deployment, ranging from urban buildings to remote rural areas. Similarly, wind energy has benefited from advancements in turbine design, materials science, and aerodynamics, resulting in higher capacity factors and lower maintenance costs. Offshore wind farms, in particular, are emerging as major contributors to national grids, taking advantage of stronger and more consistent wind resources. The integration of these sources requires sophisticated power electronic converters and maximum power point tracking (MPPT) algorithms to ensure efficient energy capture and smooth interface with the grid. The ability to convert intermittent renewable outputs into stable, high-quality electricity is largely dependent on these control technologies, which play a vital role in maintaining voltage stability, frequency regulation, and power quality.

VII. CONCLUSION

The future of electrical power systems is being redefined by technological innovation, environmental responsibility, and digital transformation. The transition toward renewable-dominated, intelligent, and decentralized grids marks a new era in the history of electricity. Although challenges related to intermittency, cost, and cybersecurity persist, the collective momentum of governments, industries, and researchers is propelling the sector toward resilience and sustainability. The widespread adoption of AI, smart grids, power electronics, and storage solutions is unlocking new dimensions of efficiency and flexibility. Furthermore, the electrification of transport and the rise of prosumer-driven models are reshaping both the technical and economic landscape of energy systems. As the world strives to meet its climate goals, the modernization of power infrastructure becomes both an obligation and an opportunity. Collaboration between technological innovation and policy reform will be key to ensuring equitable access to clean and affordable energy. Ultimately, the future electrical power system will not only serve as the backbone of industrial and societal progress but also as a catalyst for a sustainable planet. Through continuous innovation, global cooperation, and responsible implementation, the vision of a fully digital, carbon-neutral, and intelligent energy network can be realized.

REFERENCES

[1]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “A New Soft Computing Fuzzy Logic Frequency Regulation Scheme for Two Area Hybrid Power Systems,” Int. J. Electr. Electron. Res., vol. 11, no. 3, pp. 705–710, 2023.
[2]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “An innovative fuzzy logic frequency regulation strategy for two-area power systems,” Int. J. Power Electron. Drive Syst. IJPEDS, vol. 15, no. 1, pp. 603–610, 2024.
[3]. N. Nireekshana, R. Ramachandran, and G. Narayana, “A Novel Swarm Approach for Regulating Load Frequency in Two-Area Energy Systems,” Int J Electr Electron Res, vol. 11, pp. 371–377, 2023.
[4]. N. Namburi Nireekshana and K. R. Kumar, “A Modern Distribution Power Flow Controller With A PID-Fuzzy Approach: Improves The Power Quality”, Accessed: Oct. 28, 2025. [Online]. Available:

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25nov147

https://www.academia.edu/download/112956747/ijeer_120124.pdf

[5]. N. Nireekshana, R. R. Chandran, and G. V. Narayana, "Frequency Regulation in Two Area System with PSO Driven PID Technique," J Power Electron Power Syst, vol. 12, no. 2, pp. 8–20, 2022.

[6]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, "Novel Intelligence ANFIS Technique for Two-Area Hybrid Power System's Load Frequency Regulation," in E3S Web of Conferences, EDP Sciences, 2024, p. 02005. Accessed: Oct. 28, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2024/02/e3sconf_icregcsd2023_02005/e3sconf_icregcsd2023_02005.html

[7]. N. Nireekshana, A. Archana, and K. Pullareddy, "A Classical H6 Topology for Modern PV Inverter Design," in Power Energy and Secure Smart Technologies, CRC Press, 2025, pp. 1–7. Accessed: Oct. 31, 2025. [Online]. Available: https://www.taylorfrancis.com/chapters/edit/10.1201/9781003661917-1/classical-h6-topology-modern-pv-inverter-design-namburi-nireekshana-archana-pullareddy-kanth-rajini

[8]. C. P. Prasad and N. Nireekshan, "A Higher Voltage Multilevel Inverter with Reduced Switches for Industrial Drive," Int. J. Sci. Eng. Technol. Res. IJSETR, vol. 5, no. 1, 2016, Accessed: Oct. 29, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_24_22pm%2092.pdf

[9]. N. Nireekshana, "A POD Modulation Technique Based Transformer less HERIC Topology for PV Grid Tied-Inverter," in E3S Web of Conferences, EDP Sciences, 2025, p. 01001. Accessed: Oct. 29, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2025/16/e3sconf_icregcsd2025_01001/e3sconf_icregcsd2025_01001.html

[10]. [N. Nireekshana, R. Ramachandran, and G. V. Narayana, "A Peer Survey on Load Frequency Contol in Isolated Power System with Novel Topologies," Int J Eng Adv Technol IJEAT, vol. 11, no. 1, pp. 82–88, 2021.

[11]. N. NIREEKSHANA, R. Ramachandran, and G. V. Narayana, "An intelligent technique for load frequency control in hybrid power system," 2023, Accessed: Oct. 31, 2025. [Online]. Available: https://www.academia.edu/download/107660997/latest.pdf

[12]. N. Nireekshana, R. R. Chandran, and G. V. Narayana, "Frequency Regulation in Two Area System with PSO Driven PID Technique," J Power Electron Power Syst, vol. 12, no. 2, pp. 8–20, 2022.

[13]. N. NIREEKSHANA, A. SHIVA, A. FURKHAN, M. SRIDHAR, A. OMPRAKASH, and K. K. SHIVA, "SIX PULSE TYPE SEGMENTED THYRISTOR CONTROLLED REACTOR WITH FIXED CAPACITOR FOR REACTIVE POWER COMPENSATION," Int. J., pp. 3153–3159, 2024.

[14]. N. Nireekshana, M. A. Goud, R. B. Shankar, and G. N. S. Chandra, "Solar Powered Multipurpose Agriculture Robot," Int. J. Innov. Sci. Res. Technol., vol. 8, no. 5, p. 299, 2023.

[15]. N. Nireekshana, "Reactive Power Compensation in High Power Applications by Bidirectionalcasceded H-Bridge Based Statcom", Accessed: Oct. 31, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_45_47pm%20152.pdf

[16]. N. Nireekshana, K. P. Reddy, A. Archana, and P. R. Kanth, "Solar-Assisted Smart Driving System for Sustainable Transportation," Int. J. Innov. Sci. Res. Technol., vol. 10, no. 8, pp. 168–173, 2025.

[17]. Namburi Nireekshana, Tanvi H Nerlekar, P. N. Kumar, and M. M. Bajaber, "An Innovative Solar Based Robotic Floor Cleaner," May 2023, doi: 10.5281/ZENODO.7918621.

[18]. Namburi Nireekshana, Onteru Divya, Mohammed Abdul Saquib Adil, Rathod Rahul, and Mohammed Shoaib Mohiuddin, "An Innovative SSSC Device for Power Quality Enhancement," Feb. 2024, doi: 10.5281/ZENODO.10670526.

[19]. Namburi Nireekshana, K. Pulla Reddy, Reyya Bose Babu, Bonda Sunder, G. Sumanth Kumar, and P. Vivekananda Raj, "Static Var Compensator for Reactive Power Control," Feb. 2024, doi: 10.5281/ZENODO.10638477.

[20]. Namburi Nireekshana, A. Archana, Setla Manvitha, Mohammed Saad Ahmed, Nisar Ahmed Khan, and Akellu George Muller, "Unique Facts Device for Power Quality Mitigation," Feb. 2024, doi: 10.5281/ZENODO.10652911.

[21]. Namburi Nireekshana, Manmarry Vaibhav Murali, Makka Harinath, Ch. Vishal, and Ankam Sandeep Kumar, "Power Quality Improvement by Thyristor Controlled Series Capacitor," Feb. 2024, doi: 10.5281/ZENODO.10669448.

[22]. B. Jula and N. Nireekshan, "Improving the Voltage Profile at Load End using DVR.," Grenze Int. J. Eng. Technol. GIJET, vol. 4, no. 3, 2018, Accessed: Nov. 03, 2025. [Online]. Available: https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=23955287&AN=134178998&h=YQk2OkwoPFcVuqJX%2B1rKA0Mbu%2B3%2FNRInXZhf6Wu1MJR4MoiWNdCgc7k4H5aV7e79V%2BdpemgvHWYJbJToV64CuQ%3D%3D&crl=c

[23]. N. Nireekshana, A. Archana, and K. Pullareddy, "A Classical H6 Topology for Modern PV Inverter Design," in Power Energy and Secure Smart Technologies, CRC Press, 2025, pp. 1–7. Accessed: Nov. 03, 2025. [Online]. Available: https://www.taylorfrancis.com/chapters/edit/10.1201/9781003661917-1/classical-h6-topology-modern-pv-inverter-design-namburi-nireekshana-archana-pullareddy-kanth-rajini

[24]. N. Namburi Nireekshana and K. R. Kumar, "A Modern Distribution Power Flow Controller With A PID-Fuzzy Approach: Improves The Power Quality", Accessed: Nov. 03, 2025. [Online]. Available: https://www.academia.edu/download/112956747/ijeer_120124.pdf

[25]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, "An innovative fuzzy logic frequency regulation strategy for two-area power systems," Int. J. Power Electron. Drive Syst. IJPEDS, vol. 15, no. 1, pp. 603–610, 2024.

[26]. N. NIREEKSHANA, R. Ramachandran, and G. V. Narayana, "An intelligent technique for load frequency control in hybrid power system," 2023, Accessed: Nov. 03, 2025. [Online]. Available:

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25nov147

https://www.academia.edu/download/107660997/latest.pdf

[27]. N. Nireekshana, R. R. Chandran, and G. V. Narayana, "Frequency Regulation in Two Area System with PSO Driven PID Technique," J Power Electron Power Syst, vol. 12, no. 2, pp. 8–20, 2022.

[28]. R. Jatoth and N. Nireekshana, "Improvement of Power Quality in Grid Connected Non Coventional Energy Sources at Distribution Loads," Grenze Int J Eng Technol GIJET, vol. 4, no. 3, 2018, Accessed: Nov. 03, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_58_06pm%20201.pdf

[29]. N. Nireekshana, T. H. Nerlekar, P. N. Kumar, and M. M. Bajaber, "An Innovative Solar Based Robotic Floor Cleaner," Int. J. Innov. Sci. Res. Technol. IJISRT, vol. 8, no. 4, pp. 1880–1885, 2023.

[30]. N. Nireekshana, N. Ravi, and K. R. Kumar, "A Modern Distribution Power Flow Controller With A PID-Fuzzy Approach: Improves The Power Quality," Int. J. Electr. Electron. Res., vol. 12, no. 1, pp. 167–171, 2024.

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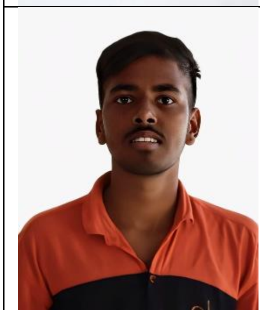	**Joginapalli Ajay** is completed SSC at ZPHS Dwaraka, and studied diploma at Govt. PolyTechnic Kotagiri. He is persuing BE Electrical and Electronics Engineering at Methodist College of Engineering, Hyderabad
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