Review Article

Power Distribution Innovations: An Overview of Up-and-Coming Trends and Technologies

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I N F O

A B S T R A C T

The evolution of power distribution systems is at the forefront of efforts to meet the challenges of growing energy demand, climate change mitigation, and the integration of renewable energy sources. This review article explores recent innovations and trends in power distribution, focusing on technologies and strategies that are reshaping the electricity grid. From the implementation of smart grids and the proliferation of distributed energy resources (DERs) to advancements in energy storage and grid resilience, this review provides an overview of key developments and their implications. Additionally, the electrification of transportation, digitalization, and data analytics are discussed as transformative elements in modernizing power distribution infrastructure. Understanding these emerging technologies and addressing associated challenges is crucial for building efficient, resilient, and sustainable power distribution systems capable of meeting future energy needs.

Keywords: Smart Meters, Predictive Maintenance, Grid Optimization, Big Data Analytics, Customer Engagement

Introduction

The global demand for electricity continues to rise, driven by population growth, urbanization, and industrialization. This surge in demand, coupled with the imperative to reduce greenhouse gas emissions and enhance energy security, has spurred significant innovation in power distribution systems. This review aims to delve into recent developments and emerging trends that are revolutionizing how electricity is generated, transmitted, and consumed.

Traditionally, power distribution has been characterized by centralized generation and one-way power flow from large-scale power plants to consumers. However, the advent of smart grids, distributed energy resources (DERs), and advancements in energy storage technologies are challenging this paradigm. These innovations promise enhanced efficiency, reliability, and sustainability while enabling greater integration of renewable energy sources into the grid.

As we transition towards a more decentralized and interconnected energy landscape, understanding the implications of these innovations is crucial. This review will explore key technological advancements, highlight challenges and opportunities, and discuss the potential future directions of power distribution systems. From microgrids to grid modernization initiatives, the journey towards a smarter, more resilient power grid is underway, promising a more sustainable energy future for generations to come.[1-4]

Smart Grids

Smart grids represent a transformative approach to power distribution, leveraging advanced communication, sensing, and control technologies to optimize grid operations and enhance reliability. By integrating real-time data analytics and two-way communication capabilities, smart grids enable more efficient energy management, load balancing,

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and outage response. Key components and features of smart grids include:

- **Advanced Metering Infrastructure (AMI):** Smart meters are a cornerstone of smart grid technology, enabling remote meter reading, real-time consumption monitoring, and demand response programs. AMI allows utilities and consumers to better understand and manage their energy usage, leading to more informed decision-making and energy conservation.

- **Grid Automation and Control:** Automation technologies enable self-healing capabilities within the grid, reducing the duration and impact of outages. Automated switching, fault detection, and voltage regulation improve grid reliability and minimize disruptions. Additionally, distributed control systems optimize power flow and voltage levels, improving overall grid efficiency.

- **Integration of Renewable Energy:** Smart grids facilitate the integration of renewable energy sources such as solar photovoltaics and wind turbines by providing real-time visibility into generation and consumption patterns. Advanced forecasting algorithms help utilities manage the variability of renewable generation and ensure grid stability.

- **Demand Response Programs:** Smart grids enable dynamic pricing schemes and demand response programs, allowing utilities to incentivize consumers to shift their electricity usage during peak demand periods. This helps to reduce strain on the grid, avoid costly infrastructure upgrades, and lower electricity costs for consumers.

- **Cybersecurity and Resilience:** As smart grids become increasingly reliant on digital communication and control systems, cybersecurity becomes a critical concern. Robust cybersecurity measures are essential to protect against cyber threats and ensure the integrity and reliability of the grid. Additionally, smart grids enhance grid resilience by isolating and rerouting power in the event of disruptions or attacks.

- **Data Analytics and Predictive Maintenance:** Smart grids generate vast amounts of data, which can be analyzed to optimize grid operations and maintenance. Predictive analytics algorithms can detect equipment failures before they occur, enabling proactive maintenance and reducing downtime.

- **Electric Vehicle (EV) Integration:** Smart grids support the integration of electric vehicles by managing charging infrastructure, optimizing charging schedules, and leveraging vehicle-to-grid (V2G) technology. V2G allows EV batteries to store excess energy and provide grid services during peak demand periods, enhancing grid stability and flexibility.[5,6]

Distributed Energy Resources (DERs)

Distributed Energy Resources (DERs) are decentralized energy sources and storage systems located close to the point of energy consumption. They offer a diverse array of generation options, including solar photovoltaics (PV), wind turbines, micro-hydro generators, combined heat and power (CHP) systems, and energy storage technologies. DERs play a pivotal role in reshaping power distribution systems by increasing flexibility, reliability, and sustainability. Key aspects of DERs include:

- **Solar Photovoltaics (PV):** Solar PV systems, installed on rooftops or in small-scale solar farms, generate electricity from sunlight. The plummeting costs of solar panels have made PV systems one of the most popular DERs, enabling consumers to generate their own electricity and reduce reliance on the grid.

- **Wind Turbines:** Small-scale wind turbines, often installed in rural or coastal areas, harness wind energy to generate electricity. Wind power complements solar PV by providing generation during periods of low solar output. Advances in turbine design and efficiency have made wind energy increasingly cost-effective and accessible.

- **Energy Storage Systems:** Batteries, flywheels, pumped hydro storage, and other energy storage technologies play a crucial role in balancing supply and demand on the grid. Energy storage systems store excess energy generated by DERs for use during periods of high demand or when renewable generation is low. They also provide backup power and grid stabilization services.

- **Combined Heat and Power (CHP) Systems:** CHP systems, also known as cogeneration, simultaneously generate electricity and useful heat from a single fuel source. They are highly efficient compared to traditional power plants since they utilize waste heat for heating or cooling purposes, making them ideal for commercial and industrial applications.

- **Demand Response and Energy Efficiency Measures:** Demand response programs and energy efficiency measures are considered DERs since they reduce overall electricity demand and alleviate strain on the grid. Demand response involves adjusting electricity usage in response to price signals or grid conditions, while energy efficiency measures reduce energy consumption without sacrificing comfort or productivity.

- **Grid Services and Ancillary Benefits:** DERs can provide a range of grid services, including frequency regulation, voltage support, and reactive power control. They enhance grid resilience, reduce transmission losses, and improve power quality, contributing to a more stable and reliable electricity supply.

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- **Regulatory and Market Challenges:** Despite their numerous benefits, DER deployment faces regulatory and market barriers such as interconnection standards, net metering policies, and compensation mechanisms. Clear and transparent regulations are needed to incentivize investment in DERs and ensure fair compensation for their grid services.
- **Integration and Grid Interoperability:** Integrating DERs into the grid requires advanced control and communication systems to manage their variability and intermittency. Interoperability standards and grid-edge technologies are crucial for seamless integration and coordination of DERs with existing grid infrastructure.[7-9]

Microgrids

Microgrids represent a localized approach to power distribution, consisting of interconnected loads and distributed energy resources (DERs) that can operate independently from the main grid or in conjunction with it. They provide resilient and sustainable energy solutions for communities, campuses, industrial complexes, and remote areas. Microgrids offer several advantages, including:

- **Resilience and Reliability:** Microgrids enhance energy resilience by providing backup power during grid outages or disruptions. They can island themselves from the main grid and continue to supply electricity to critical loads, ensuring uninterrupted operation for essential services such as hospitals, data centers, and emergency facilities.
- **Integration of Renewable Energy:** Microgrids often incorporate renewable energy sources such as solar PV, wind turbines, and biomass generators. By leveraging local renewable resources, microgrids reduce dependence on fossil fuels, lower carbon emissions, and contribute to environmental sustainability.
- **Energy Access in Remote Areas:** Microgrids play a crucial role in providing reliable electricity access to remote communities and off-grid regions where extending the main grid is impractical or uneconomical. Renewable energy-based microgrids offer a cost-effective and sustainable solution for electrification in underserved areas.
- **Grid Support and Ancillary Services:** Microgrids can provide grid support services such as frequency regulation, voltage control, and reactive power support to the main grid. They enhance overall grid stability and reliability by alleviating strain during peak demand periods or grid disturbances.
- **Energy Independence and Security:** Microgrids offer energy independence by allowing communities or facilities to generate and manage their own electricity supply locally. This reduces vulnerability to grid disruptions, energy price fluctuations, and geopolitical risks associated with imported energy sources.
- **Scalability and Flexibility:** Microgrids can be designed to scale from small residential systems to large-scale industrial installations. They offer flexibility in system design and operation, allowing for modular expansion and integration of new technologies as energy needs evolve.
- **Advanced Control and Management Systems:** Control systems and automation technologies are essential components of microgrids, enabling seamless coordination of generation, storage, and demand-side resources. Advanced microgrid controllers optimize energy dispatch, prioritize critical loads, and maximize system efficiency.
- **Regulatory and Financial Considerations:** Regulatory frameworks and financial incentives play a significant role in the deployment of microgrids. Clear policies for interconnection, grid tariffs, and market participation are needed to facilitate investment in microgrid projects and ensure fair compensation for grid services.[10-13]

Energy Storage Technologies

Energy storage technologies play a critical role in enabling the integration of renewable energy, improving grid stability, and enhancing the overall flexibility and reliability of power distribution systems. They store excess energy during periods of low demand and release it when demand is high, smoothing out fluctuations in generation and consumption. Various energy storage technologies are being deployed, each offering unique characteristics and applications:

- **Lithium-ion Batteries:** Lithium-ion batteries are the most widely deployed energy storage technology, known for their high energy density, efficiency, and rapid response times. They are used in stationary storage applications, electric vehicles (EVs), and grid-scale energy storage projects. Advances in battery chemistry and manufacturing processes continue to drive down costs and improve performance.
- **Flow Batteries:** Flow batteries store energy in chemical electrolytes housed in separate tanks, offering scalability and long cycle life. Vanadium redox flow batteries (VRFBs) are the most common type of flow battery used in grid-scale applications. Flow batteries are well-suited for long-duration storage and provide grid stabilization services.
- **Pumped Hydro Storage:** Pumped hydro storage utilizes the potential energy of water by pumping it to a higher elevation during periods of low demand and releasing it through turbines to generate electricity when demand is high. Pumped hydro facilities are the largest and most established form of grid-scale energy storage, offering high efficiency and long-term storage capabilities.

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- Compressed Air Energy Storage (CAES): CAES systems store energy by compressing air into underground caverns or tanks and releasing it to drive turbines and generate electricity when needed. CAES offers fast response times and can be coupled with renewable energy sources to provide dispatchable power.

- Thermal Energy Storage: Thermal energy storage systems store heat or cold using materials such as molten salts, phase-change materials, or ice. They are commonly used for heating and cooling applications in buildings, industrial processes, and concentrated solar power (CSP) plants. Thermal storage enhances energy efficiency and reduces peak electricity demand.

- Hydrogen Storage: Hydrogen can be stored and converted back to electricity using fuel cells when needed. Hydrogen storage offers long-duration storage capabilities and can be produced from renewable sources, making it a promising option for storing excess renewable energy and decarbonizing various sectors, including transportation and industry.

- Flywheels: Flywheel energy storage systems store kinetic energy in a spinning rotor and convert it back to electricity as needed. Flywheels provide rapid response times and are used for short-duration grid stabilization applications, frequency regulation, and uninterruptible power supply (UPS) systems.

- Emerging Technologies: Research is ongoing into novel energy storage technologies such as solid-state batteries, supercapacitors, and gravitational storage systems, which offer potential advantages in terms of safety, cost, and scalability.[14-17]

Grid Modernization and Resilience

Grid modernization initiatives are essential for ensuring the reliability, resilience, and efficiency of power distribution systems in the face of evolving energy challenges, climate change impacts, and technological advancements. Modernizing the grid involves upgrading infrastructure, integrating advanced technologies, and implementing innovative strategies to enhance grid resilience and flexibility. Key aspects of grid modernization and resilience include:

- **Infrastructure Upgrades:** Aging infrastructure poses reliability risks and limits the integration of new technologies. Grid modernization efforts involve upgrading substations, transformers, and distribution lines to improve efficiency, reduce losses, and accommodate increased demand and renewable energy integration.

- **Advanced Sensors and Monitoring Systems:** Grid modernization incorporates the deployment of advanced sensors, communication networks, and real-time monitoring systems to detect faults, assess grid conditions, and optimize asset performance. Smart sensors enable predictive maintenance, reducing downtime and enhancing grid reliability.

- **Grid Edge Technologies:** Technologies deployed at the grid edge, such as distributed energy resources (DERs), smart meters, and grid-connected devices, play a crucial role in grid modernization. These technologies enable bidirectional communication, dynamic control, and optimization of grid operations at the distribution level.

- **Resilience Planning and Grid Hardening:** Grid modernization initiatives include resilience planning and grid hardening measures to withstand extreme weather events, cyber-attacks, and other disruptions. Hardening infrastructure, burying power lines, and implementing redundant systems improve grid resilience and reduce outage duration.

- **Microgrids and Islanding Capability:** Microgrids provide localized energy solutions and enhance grid resilience by operating autonomously during grid outages. Integrating microgrid capabilities into the main grid allows for islanding, where critical facilities or communities can continue to receive power even when disconnected from the main grid.

- **Cybersecurity Measures:** As the grid becomes increasingly digitized and interconnected, cybersecurity is paramount to protect against cyber threats and ensure the integrity of grid operations. Grid modernization initiatives incorporate robust cybersecurity measures, including encryption, access controls, and threat detection systems.

- **Grid Flexibility and Demand-Side Management:** Grid modernization facilitates demand-side management programs, dynamic pricing, and flexible load control to match supply with demand in real-time. These strategies optimize grid operations, reduce peak demand, and enhance overall system efficiency.

- **Integration of Resilient Technologies:** Grid modernization involves integrating resilient technologies such as energy storage, microgrids, and renewable energy sources into the grid architecture. These technologies provide backup power, enhance grid stability, and reduce dependence on centralized generation.

- **Community Engagement and Public Awareness:** Engaging communities and increasing public awareness about grid modernization efforts, resilience planning, and emergency preparedness is crucial for building support and resilience at the grassroots level.

Electrification of Transportation

The electrification of transportation represents a significant paradigm shift in the energy sector, with profound implications for power distribution systems, energy markets, and environmental sustainability. As electric vehicles (EVs) gain traction, power distribution networks are evolving to support increased electricity demand, optimize charging

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infrastructure, and integrate EVs as grid assets. Key aspects of the electrification of transportation include:

- **EV Adoption Trends:** The adoption of electric vehicles is accelerating globally, driven by advancements in battery technology, supportive policies, and growing environmental awareness. Electric cars, buses, trucks, and two-wheelers are becoming increasingly common, leading to a surge in electricity demand for transportation.

- **Charging Infrastructure:** Grid modernization efforts include the deployment of EV charging infrastructure to support the growing number of electric vehicles on the road. This includes public charging stations, workplace charging, residential charging solutions, and fast-charging networks along highways.

- **Smart Charging Solutions:** Smart charging technologies enable efficient and grid-friendly EV charging by optimizing charging schedules, managing load profiles, and coordinating charging based on grid conditions and electricity prices. Vehicle-to-grid (V2G) technology allows EVs to discharge electricity back to the grid, providing demand response capabilities and grid support services.

- **Grid Impact and Load Management:** The widespread adoption of EVs poses challenges and opportunities for power distribution systems. Managing the impact of EV charging on the grid requires load management strategies, demand response programs, and grid-friendly charging protocols to avoid peak demand spikes and infrastructure upgrades.

- **Integration with Renewable Energy:** EV charging can be integrated with renewable energy sources to maximize environmental benefits and reduce greenhouse gas emissions. Time-of-use pricing and dynamic tariffs encourage EV owners to charge during periods of high renewable energy generation, further reducing carbon footprint.

- **Vehicle-to-Grid (V2G) Technology:** V2G technology allows bidirectional power flow between EV batteries and the grid, enabling EVs to serve as mobile energy storage devices. V2G provides grid services such as peak shaving, frequency regulation, and energy arbitrage, enhancing grid stability and flexibility.

- **Electrification of Public Transit and Fleets**: Electrifying public transit systems, taxis, delivery fleets, and other commercial vehicles is a key strategy to reduce emissions and improve air quality in urban areas. Fleet electrification initiatives are driving innovation in charging infrastructure and vehicle-to-grid integration.

- **Policy and Regulatory Frameworks:** Supportive policies, incentives, and regulatory frameworks are essential for accelerating the electrification of transportation. This includes financial incentives for EV purchases, infrastructure investments, emission regulations, and grid integration standards.

- **Consumer Awareness and Education:** Increasing consumer awareness about the benefits of electric vehicles, charging options, and grid impacts is crucial for promoting EV adoption and facilitating a smooth transition to electrified transportation.

Digitalization and Data Analytics

Digitalization and data analytics are revolutionizing power distribution systems, enabling utilities to optimize grid operations, improve reliability, and enhance customer engagement. By leveraging advanced technologies such as sensors, communication networks, and artificial intelligence, power distribution companies can extract valuable insights from data and make data-driven decisions to optimize grid performance. Key aspects of digitalization and data analytics in power distribution include:

- **Advanced Metering Infrastructure (AMI):** AMI systems, including smart meters, enable real-time monitoring of energy consumption and provide valuable data for grid optimization. Smart meters facilitate remote meter reading, time-of-use pricing, and demand response programs, empowering consumers to manage their energy usage more efficiently.

- **Sensor Networks and IoT Devices:** Sensors deployed throughout the grid collect data on voltage, current, temperature, and other parameters, providing insights into grid health and performance. Internet of Things (IoT) devices enable remote monitoring, asset management, and predictive maintenance of grid infrastructure.

- **Big Data Analytics:** Utilities analyze large volumes of data collected from sensors, meters, and other sources to identify patterns, trends, and anomalies. Big data analytics techniques, including machine learning and predictive analytics, help utilities forecast energy demand, optimize grid operations, and detect potential failures before they occur.

- **Grid Optimization and Load Balancing:** Data analytics tools optimize grid operations by balancing supply and demand in real-time, reducing energy losses, and improving overall grid efficiency. Predictive algorithms forecast load patterns and adjust generation and distribution accordingly to minimize peak demand and avoid congestion.

- Fault Detection and Predictive Maintenance: Data analytics enable early detection of grid faults, equipment failures, and performance degradation. Predictive maintenance algorithms analyze equipment health data to schedule maintenance proactively, reducing downtime and extending asset lifespan.

- Outage Management and Response: Real-time data

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analytics facilitate faster outage detection and response by pinpointing the location and cause of outages. Predictive analytics anticipate potential failure points and enable utilities to deploy resources more effectively to restore power quickly.

- Customer Engagement and Energy Services: Digitalization enables utilities to offer personalized energy services, energy usage insights, and demand-side management programs to consumers. Smart energy apps, online portals, and energy dashboards empower customers to monitor their usage, optimize efficiency, and participate in energy-saving initiatives.

- Cybersecurity and Data Privacy: With increased digitalization comes heightened concerns about cybersecurity and data privacy. Utilities implement robust cybersecurity measures, encryption protocols, and access controls to protect sensitive data and ensure the integrity and confidentiality of grid operations.

- Regulatory and Policy Considerations: Regulatory frameworks play a crucial role in fostering digitalization and data analytics in the power sector. Clear regulations, standards, and incentives encourage investment in digital technologies and data-driven solutions while ensuring data privacy and security compliance.[18-20]

Conclusion

The power distribution sector is undergoing a profound transformation, driven by technological innovation, sustainability goals, and evolving consumer demands. Smart grids, distributed energy resources, microgrids, energy storage, and grid modernization initiatives are reshaping the way electricity is generated, transmitted, and consumed. Addressing challenges related to grid resilience, cybersecurity, and regulatory frameworks will be crucial for realizing the full potential of these innovations and building a more sustainable and resilient energy future.

References

1. Zhang Y, Huang T, Bompard EF. Big data analytics in smart grids: a review. Energy informatics. 2018 Dec;1(1):1-24.

2. Wang D, Shi F, Yu B, Sun D, Li X, Han D, Tan Y. A numerical study on the diversion mechanisms of fracture networks in tight reservoirs with frictional natural fractures. Energies. 2018 Nov 5;11(11):3035.

3. Farhangi H. The path of the smart grid. IEEE power and energy magazine. 2009 Dec 22;8(1):18-28.

4. Syed D, Zainab A, Ghrayeb A, Refaat SS, Abu-Rub H, Bouhali O. Smart grid big data analytics: Survey of technologies, techniques, and applications. IEEE Access. 2020 Nov 27;9:59564-85.

5. Mohsenian-Rad AH, Wong VW, Jatskevich J, Schober R, Leon-Garcia A. Autonomous demand-side management based on game-theoretic energy consumption scheduling for the future smart grid. IEEE transactions on Smart Grid. 2010 Nov 18;1(3):320-31.

6. Yu C, Chai J, Han S, Liu Z, Li X, Yao J. Field performance evaluation of various crystalline silicon photovoltaic technologies in Pingshan, China. Energy Reports. 2019 Nov 1;5:525-8.

7. Syed D, Zainab A, Ghrayeb A, Refaat SS, Abu-Rub H, Bouhali O. Smart grid big data analytics: Survey of technologies, techniques, and applications. IEEE Access. 2020 Nov 27;9:59564-85.

8. Malviya A, Solanki PP. Photogalvanics: a sustainable and promising device for solar energy conversion and storage. Renewable and Sustainable Energy Reviews. 2016 Jun 1;59:662-91.

9. Barros CP, Wanke P, Dumbo S, Manso JP. Efficiency in angolan hydro-electric power station: A two-stage virtual frontier dynamic DEA and simplex regression approach. Renewable and Sustainable Energy Reviews. 2017 Oct 1;78:588-96.

10. Al-Fuqaha A, Guizani M, Mohammadi M, Aledhari M, Ayyash M. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE communications surveys & tutorials. 2015 Jun 15;17(4):2347-76.

11. Gungor VC, Sahin D, Kocak T, Ergut S, Buccella C, Cecati C, Hancke GP. Smart grid technologies: Communication technologies and standards. IEEE transactions on Industrial informatics. 2011 Sep 5;7(4):529-39.

12. Lopez-Carreiro I, Monzon A. Evaluating sustainability and innovation of mobility patterns in Spanish cities. Analysis by size and urban typology. Sustainable Cities and Society. 2018 Apr 1;38:684-96.

13. Florio C, Fiorentino G, Corcelli F, Ulgiati S, Dumontet S, Güsewell J, Eltrop L. A life cycle assessment of bio-methane production from waste feedstock through different upgrading technologies. Energies. 2019 Feb 22;12(4):718.

14. Colmenares-Quintero RF, Quiroga-Parra DJ, Rojas N, Stansfield KE, Colmenares-Quintero JC. Big Data analytics in Smart Grids for renewable energy networks: Systematic review of information and communication technology tools. Cogent Engineering. 2021 Jan 1;8(1):1935410.

15. Kumari S, Kumar N, Rana PS. Big Data Analytics for Energy Consumption Prediction in Smart Grid Using Genetic Algorithm and Long Short Term Memory. Computing & Informatics. 2021 Jan 1;40(1).

16. Zhang Y, Huang T, Bompard EF. Big data analytics in smart grids: a review. Energy informatics. 2018 Dec;1(1):1-24.

17. Zheng HH, Wang ZX. Measurement and comparison of export sophistication of the new energy industry in 30 countries during 2000–2015. Renewable and

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J. Adv. Res. Power Electro. Power Sys. 2024; 11(1)

Sustainable Energy Reviews. 2019 Jul 1;108:140-58.

18. Ponnusamy VK, Kasinathan P, Madurai Elavarasan R, Ramanathan V, Anandan RK, Subramaniam U, Ghosh A, Hossain E. A comprehensive review on sustainable aspects of big data analytics for the smart grid. Sustainability. 2021 Dec 1;13(23):13322.

19. Hu Y, Mao L, Guan X, Tucker KA, Xie H, Wu X, Shi J. Layered perovskite oxides and their derivative nanosheets adopting different modification strategies towards better photocatalytic performance of water splitting. Renewable and Sustainable Energy Reviews. 2020 Mar 1;119:109527.

20. Lin B, Tan R. Sustainable development of China's energy intensive industries: From the aspect of carbon dioxide emissions reduction. Renewable and Sustainable Energy Reviews. 2017 Sep 1;77:386-94.