

# Distribution System Integration of Emerging Technologies

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Electric power distribution systems are the first link every person has with electric power systems. Historically, power systems have been represented by three distinct components: the generation system, the transmission system, and the distribution system. The generation system produces the electric power. A high-voltage transmission system transfers bulk power to dispersed sites. A distribution system operates at lower voltages (<115kV) and delivers power at supply voltage levels directly to consumers. While much of the original work in electrical engineering focused on designing electric distribution systems, the majority of power engineering research and education has focused on high-voltage, transmission systems.

However, the transmission and distribution systems serve different purposes; their physical structures and, hence, their study are inherently different. High voltage transmission systems interconnect generation plants using multi-phase wires, i.e., have multiple sources and contain loops. In contrast, the distribution system has historically drawn power from one dominant source and often has weakly meshed or radial network structures. In addition, distribution systems supply power at lower voltages to consumers such as homes, hospitals, water treatment plants, manufacturing plants, etc. which receive their power through single, two, or three-phase wires. The different purposes, structures, and voltage levels of the transmission and distribution systems result in significantly different mathematical and computer models for the systems.

Now, the interest in electric power distribution systems is resurgent for a number of reasons. First, deregulation and the subsequent restructuring of the electric utilities have brought new operating and planning pressures for distribution energy suppliers. Second, economics and profit margins have driven commercial industries to demand uninterruptible, high-quality power for their manufacturing processes. Third, commercial and U.S. military goals are requiring the re-design and upgrading of electric distribution systems for ships, submarines, and all-electric vehicles such as tanks and airplanes. Last, but not least, with the availability of customer choice, individual customers are looking for low-cost, reliable, high-quality power. Many new technologies may enable distribution networks to exhibit such qualities as higher efficiency and improved reliability.

This talk will focus on power distribution planning and operating approaches for systems experiencing (i) an influx of automated devices, (ii) the proposed influx of distributed energy sources, and (iii) the slow, but steady integration of power electronic devices. These new technologies challenge several assumptions made during the original design and current operating policies of power distribution systems. As a consequence, significant changes to design and analysis tools are needed in order to effectively reap the promised benefits of these emerging technologies.

**Keywords:**

*Distribution systems:* Low voltage (<115kV) power delivery system.

*Distribution automation:* Devices/systems that allow for the remote monitoring, control, and operation of devices.

*Distributed generation/resources:* (In this talk) energy sources installed directly to the power distribution system (not stemming from the high voltage transmission systems).

*Reliability:* A measure of electric service quality.