## Increasing Power Transfer Capacity of Distribution Networks Using Direct Current Feeders

Authors : Akim Borbuev, Francisco de León

Abstract : Economic and population growth in densely-populated urban areas introduce major challenges to distribution system operators, planers, and designers. To supply added loads, utilities are frequently forced to invest in new distribution feeders. However, this is becoming increasingly more challenging due to space limitations and rising installation costs in urban settings. This paper proposes the conversion of critical alternating current (ac) distribution feeders into direct current (dc) feeders to increase the power transfer capacity by a factor as high as four. Current trends suggest that the return of dc transmission, distribution, and utilization are inevitable. Since a total system-level transformation to dc operation is not possible in a short period of time due to the needed huge investments and utility unreadiness, this paper recommends that feeders that are expected to exceed their limits in near future are converted to dc. The increase in power transfer capacity is achieved through several key differences between ac and dc power transmission systems. First, it is shown that underground cables can be operated at higher dc voltage than the ac voltage for the same dielectric stress in the insulation. Second, cable sheath losses, due to induced voltages yielding circulation currents, that can be as high as phase conductor losses under ac operation, are not present under dc. Finally, skin and proximity effects in conductors and sheaths do not exist in dc cables. The paper demonstrates that in addition to the increased power transfer capacity utilities substituting ac feeders by dc feeders could benefit from significant lower costs and reduced losses. Installing dc feeders is less expensive than installing new ac feeders even when new trenches are not needed. Case studies using the IEEE 342-Node Low Voltage Networked Test System quantify the technical and economic benefits of dc feeders.

Keywords : DC power systems, distribution feeders, distribution networks, power transfer capacity

Conference Title : ICPET 2020 : International Conference on Power Engineering and Technology

Conference Location : New York, United States

Conference Dates : April 23-24, 2020