This paper assesses the feasibility of three-phase pulse-width modulated (PWM) three-level voltage-source converters (VSC), namely neutral-point-clamped (3L-NPC) and T-type (3L-T) as alternatives to two-level converter (2L-VSC) for low-voltage multimegawatt renewable energy grid-connected converter applications. For this purpose, a novel design algorithm that takes switching frequency, capacity factor, modulation index, PWM scheme(s), and converter topology(ies) as input is unveiled to provide the design steps and performance benchmark for the specified topologies and modulation methods. Design of the LCL filter is also addressed, and equivalent output ripple performance criteria is used to benchmark the converter performances for a set of selected filter parameters. Main contribution of this algorithm is that it covers cost and operating factors of the design during the hardware design phase by introducing/modifying the terms of total cost of ownership (TCO) and return on investment (ROI) time considering the major energy markets. The design is detailed for 1-MVA system, and the results are summarized for 0.5 and 2-MVA systems. The study shows that 3L topologies perform more efficiently than 2L-VSC (T-type being the most prominent-with the shortest ROI), whereas the difference becomes much more prominent at the multimegawatt range, provided that all three yield equivalent outputs fulfilling the stringent grid codes.