In this paper, a new family of zero-voltage-transition (ZVT) bidirectional converters are introduced. In the proposed converters, soft-switching condition for all semiconductor elements is provided regardless of the power flow direction and without any extra voltage and current stress on the main switches. The auxiliary circuit is composed of a coupled inductor with the converter main inductor and two auxiliary switches. The auxiliary switches benefit from significantly reduced voltage stress and without requiring floating gate drive circuit. Also, by applying the synchronous rectification to the auxiliary switches body diodes, conduction losses of the auxiliary circuit are reduced. In the auxiliary circuit, the leakage inductor is used as the resonant inductor and all the magnetic components are implemented on a single core which has resulted in significant reduction of the converter volume. In the proposed converters, the reverse recovery losses of the converter-rectifying diodes are completely eliminated and hence, using the low-speed body diode of the power switch as the converter-rectifying diode is feasible. The theoretical analysis for a bidirectional buck and boost converter is presented in detail and the validity of the theoretical analysis is justified using the experimental results of a 250-W prototype converter.