The issues of the global warming and the fossil fuel exhaustion have driven the renewable energy research to the peak. One of the most rising emerging technologies among the renewable energy sources is the photovoltaic energy. In residential applications, the microinverter marks a new breakthrough in photovoltaic technology. The researchers and the industry have done a tremendous effort to overcome the inherent drawbacks of the microinverter such as conversion efficiency, power density and reliability issues. However, it seems less work has been done on the grid-connected microinverter technology with battery integration. In this dissertation, designing a microinverter that can be integrated with the PV panel and the battery to implement some or all the possible power flow scenarios has been successfully accomplished.

Various microinverter topologies have been proposed which integrate a battery as a storage element with PV panel. This allows the PV, local energy storage, and a smart integrated microinverter to be consolidated and mounted as one module on the back of the PV panel. The efficient energy management system will provide stable predictable power in grid-connected applications. The topologies feature either five or six power flow scenarios based on the power generated by PV module, the grid requirement and the battery state of charge. The power flow scenarios can be as follows: 1) only PV module providing power to the grid. 2) only battery providing power to the grid. 3) PV module providing power to the grid while charging the battery. 4) Both PV and battery providing power to the grid. 5) PV module charging the battery. 6) The grid charging the battery. All power flow scenarios are achieved with single-stage conversion between three ports with faster response, low component counts, compact size and centralized control to manage the power among the ports.