Renewable energy has become the future trend of the automobile market, which can replace part of the fuel usage by electric power. It is usually limited space for storing automobile on-board battery. Thus, to better utilize the battery power, it becomes very critical to have an efficient energy conversion device who can transfer energy from battery to amenities such as air conditioning, microwave, TV, mini refrigerator, etc. In this dissertation, a designed permanent magnet synchronous motor (PMSM) can be the energy conversion device for an electric auxiliary power unit (APU) application which will have a desired power output of 2 kW at 2 krpm, and maintain a peak efficiency above 90%. The design calls for good performance over a speed range of 1.5 krpm to 2.5 krpm. With our novel technology, the designed motor can adjust its speed, eventually maintaining a relatively constant temperature in the cabin. Besides, with a high efficiency performance, the fully charged battery sets can supply the power for the cabin for about 10 hours with the engine off. Integrated circuitry has permitted the luxury of increasingly precise control over the flow of electrical energy and has enabled automated decision-making concerning the precise application of electrical energy at rapid speed in order to achieve optimal results in a variety of endeavors. Besides, as the technology of advanced micro-controller develops, fast-response power electronic devices can be used in the motor controller. A novel design of DC to AC inverter with a high performance embedded system for driving the designed motor is developed.