CHAPTER 3

OBJECTIVES AND METHODOLOGY

3.1 INTRODUCTION

Hybridization is one approach to achieve better fuel economy in automobiles. Hybrid electric vehicle (HEV) technology has the potential to reduce urban emissions and overall petroleum consumption, if it uses grid electricity. A plug-in hybrid electric vehicle (PHEV) has the facility to plug-in to a domestic/industrial electric outlet, thereby reducing a significant portion of transportation petroleum consumption. A key benefit of plug-in hybrid technology is that the vehicle no longer depends on a single fuel source.

A unique advantage of plug-in hybrid vehicles is their capability to integrate the transportation sector and the electric power generation sector to improve the efficiency, fuel economy and reliability of both systems. Implementation of plug-in hybrid concept to two-wheelers offers greater flexibility and better utilization of resources. The most significant technical barrier in deploying commercially viable plug-in hybrid electric two-wheeler is the energy storage system and its requirements. In addition, the fuel/energy consumption depends greatly on the driving cycle over which the vehicle operates, but more important is the all-electric range. The characteristics of the battery also play a vital role in choosing the type of traction battery available in the market.

The main objective of this study is to implement the plug-in hybrid technology concept for two-wheeler by proposing a control strategy and to
demonstrate the benefits of all-electric range and fuel economy improvements. The work also focuses on the investigation to evaluate the energy requirements, its mass and initial cost of the battery pack for daily average travel needs of plug-in hybrid electric two-wheelers in India. This study also investigated the influence of driving cycle and all-electric range on battery parameters for three different battery types and driving cycles. The objective also focuses on the assessment of annual gasoline/petrol saving and there by carbon dioxide emission reduction from the two-wheeler segment in India for the next decade. The following section gives the objectives of this work in detail.

3.2 OBJECTIVES

The objectives of the research work are stated as follows.

i) To develop a simple vehicle model and simulation for sizing of powertrain components followed by selection of powertrain components.

ii) To propose and develop a simple control strategy for the plug-in hybrid electric two-wheeler suitable for city driving conditions.

iii) To develop a plug-in hybrid electric two-wheeler by converting available conventional two-wheeler with a suitable motor and battery.

iv) To conduct testing and performance of powertrain elements and develop a prototype vehicle followed by validation of the simulation results.
v) To investigate the influence of all-electric range and driving cycle on battery energy and power requirements.

vi) To estimate the battery pack cost based on battery type and driving cycle and also to study the battery cycle life on payback period.

vii) To assess the annual saving of gasoline and reduction of CO₂ emission for the span of next 10 years.

3.3 METHODOLOGY

To achieve the above stated objectives, the following methodologies are to be used.

i) A mathematical vehicle model will be developed and MATLAB simulation will be carried out for evaluation of power and energy requirements for a plug-in hybrid electric two-wheeler for different driving cycles.

ii) A simple control strategy has to be developed for Indian city driving conditions with less fuel consumption for reducing emissions.

iii) A conventional two-wheeler will be converted into a plug-in hybrid electric two-wheeler by retrofitting a hub motor in the front wheel.

iv) Experiments will be carried out on engine and electric hub motor to estimate the power and torque requirements for various operating conditions.
v) A detailed investigation will be carried out to estimate the battery energy and power requirements for various conditions.

vi) A cost benefit analysis will be carried out to estimate the battery pack cost and its payback period.

vii) An assessment of annual petroleum saving and greenhouse gas emission reduction from the two-wheeler segment in India in the next decade will be carried out using a simple emission model.

Methodology to be adopted for this work is shown in Figure 3.1

The next chapter discusses the modeling and simulation based on a given driving cycle to estimate the vehicle energy and power requirements. Chapter 4 also discusses the survey conducted in Coimbatore city to study the average daily travel distance by two-wheelers followed by selection of powertrain components for the prototype vehicle.
Figure 3.1 Methodology adopted for this work