

**Combined scheduling of electric vehicles and renewable energy  
under uncertainty**



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## **DEDICATED TO**

I would like to dedicate my work to my teachers, my supervisor and my family who stood by me through thick and thin and whose continuous support paved the way for me to work hard and complete the project.

## **Abstract**

The increasing energy demand due to industrial and consumer load as well as population has made it imperative to seek out various other resources to harness power. Conventional methods of electric power generation have failed to keep up with the demand in the energy; it is a rather depleting source of power production. These hydrocarbon fuels also pose a serious threat to the environment as the global warming has increased significantly due to their use. The need of the hour is to develop such a system which would be able to cater the needs of the increased energy demand as well as be less of a threat to the environment. Much research has been done on the renewable energy resources and it has produced significant results. With the advancement in research and development, more efficient and better means of electric power production have been devised. The instances include the ever-improving PV panels, Wind energy units and Energy produced from biomass etc. The concept of micro-grid is exactly the crux of the above discussion where conventional power producing resources work in parallel with the renewable energy resources in order to provide smooth and uninterrupted power supply. Clever algorithms and methods have been devised so that all resources work in synchronism with each other in an optimal way. The aim is to amalgamate the resources in such a way that we are able to get the maximum output power at a minimum cost. Various cost effective optimization schemes have been employed in order to yield a balanced system with a low operating cost and a very good efficiency. Incorporation of the optimization methods into the system not only renders it cost effective and efficient, it can also produce profit to consumer when the designed system supplies power to the grid. The demand of electrical vehicles has risen significantly in the recent years. These vehicles offer zero emissions resulting in no harm to the environment. Vehicle to grid (V2G) is technique that has evolved over the years in the developed countries where a fleet of electrical vehicles can provide surplus power back into the grid hence profiting the consumer. Later in this dissertation, this V2G strategy has been extensively addressed. The aim of this dissertation is to provide a combined Electric vehicle and renewable energy resources schedule using the technique of stochastic programming.

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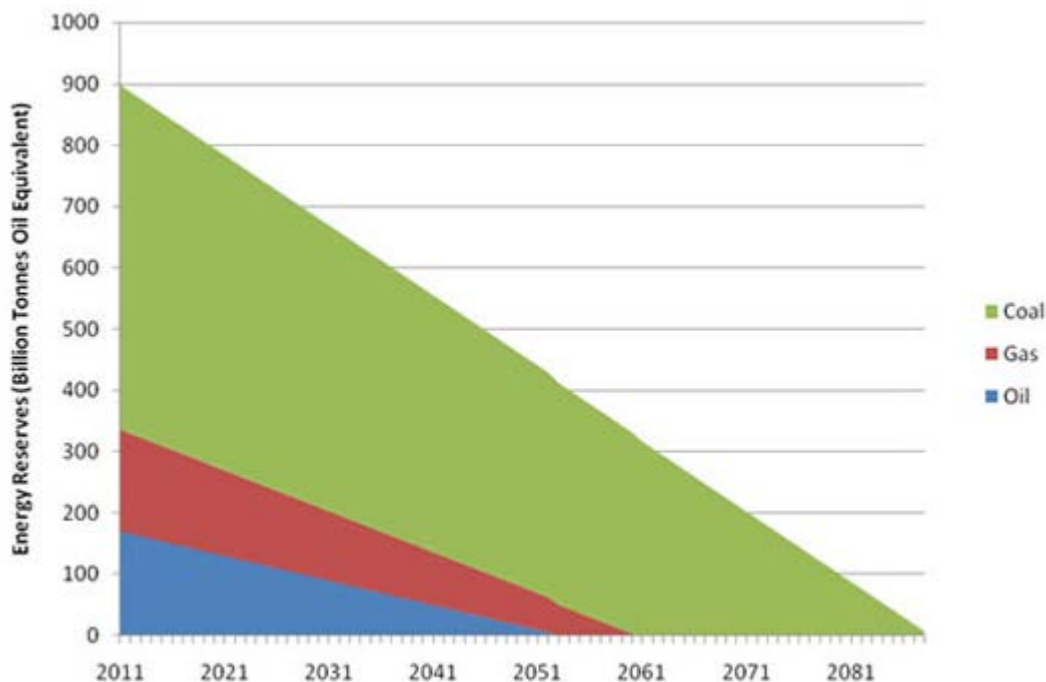
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## 1. INTRODUCTION

### 1.1 NEED FOR RENEWABLE ENERGY AND ELECTRIC VEHICLES

As the demand for electrical energy has increased over the years, new ways have been devised to cater the demands in the increasing energy. Fuels are a depleting source of energy and according to statistics 11 billion tons of fossil fuel is used all over the world. It is a startling statistic and if the pace of using the fuel is kept the same, very soon the world would run out of fuel. Same is the story with crude oil that is being utilized at 4 billion tons per annum. If the utilization of the fuels is kept at the same rate even without taking in consideration the growing population, the oil deposits are believed to be gone by 2052. Similarly, the coal reserves are believed to run out by 2088.

The need of the hour is to develop such automotive devices which would utilize some other means to run rather than consuming the fuels. In this way, the burden on petroleum industry can be greatly reduced. The figure below shows the decreasing trend as discussed.



*Figure 1: Energy reserves vs Time*

Electrical Vehicles (EVs) are an excellent example of the afore mentioned discussion. Instead of using the fossil fuels, the electric vehicles employ batteries and motors for their propulsion. This also reduces the strain the petroleum industry as well as the environment. The CO<sub>2</sub> emissions are known to be drastically reduced which means that the EVs are in no way a menace to the environment. The green houses gas effect has also be reduced by the use of energy efficient electric vehicles. Zero emission electrical vehicles have been designed which yield optimum efficiencies and cause no hazard to the environment. An electrical vehicle uses an electric/traction motors to provide the power to the shafts rather using the convention system of fuel for propulsion. The types of EVs are discussed below: