Sustainability of any civilization depends upon its energy resources, and the technological capital for their conversion and conservation. Till present day, the need for energy resources to support healthy and quality life for humankind has shown an ever-increasing trend. The depleting conventional energy resources cannot meet the future energy needs of our country and the world as a whole. This has led to an intensive search to identify new non-conventional renewable energy resources and conversion techniques to transform these resources to useful forms. Solar, wind, biomass, geothermal, ocean wave and tidal are few of the potential energy resources that have been identified. These renewable resources are environment-friendly as compared to the conventional fossil fuel resources. But, renewables have some constraints such as non-equitable distribution throughout the globe, low conversion efficiency and high cost. The “nano” science and technology provides a scope to address many of the multi-dimensional problems related to cost and efficiency of the renewable energy conversion systems and devices. Carbon based nanomaterials like carbon nanotube, carbon nanofibers, carbon nanobeads etc., because of their unique physico-chemical characteristics, have shown immense potential in the development of various energy systems adding a new dimension to the search for better systems and technologies. Carbon nanotube (CNT) is one of the most promising candidates out of all the nanoforms of carbon. But, all the carbon based nanomaterials are synthesized using low molecular weight hydrocarbons precursors derived from petroleum sources. It is the demand of the hour to develop and design techniques which have green origin and which follow green protocols. Thus, as a first step, it is endeavoured to look for suitable renewable green precursors for the synthesis of CNT. This forms the first objective of the thesis. The second objective is to synthesize CNTs from the selected plant precursors. Few plant based precursors have already been successfully used to synthesize multiwalled carbon nanotube (MWCNT). A number of technologies such as chemical vapour
deposition (CVD), physical vapour deposition (PVD) etc. have been used. Out of these the CVD technique seems to be most appropriate. A CVD system with provision for controlling the input parameters through suitable mechanism is employed for this. Such a system facilitates in the determination of the optimum conditions for synthesis of CNTs having high quality and yield. This is expected to help in achieving the **third objective of the thesis, which is to optimize the synthesis parameters** (viz. temperature, flow rate, precursor type used, etc.). It may be noted that renewable precursors consist of a mixture of a number of hydrocarbon molecules. This makes the optimization process for synthesis of CNTs from renewable precursors highly demanding. Hence to reduce the time, effort and resources which are needed in the optimization process a resort to suitable statistical techniques is essential. The optimization process is complemented by characterization of the MWCNTs synthesized under different conditions. Characterization of MWCNTs helps in ascertaining identification of their uniqueness and suitability to different energy applications. It is expected that only a few of them will satisfy the requirements for a particular application. One of the main targets of the thesis is to demonstrate the applicability of these CNTs synthesized from plant precursors in renewable energy systems and applications. Hence **the final objective of the thesis is to demonstrate the application of MWCNTs synthesized from plant precursors in energy systems** like organic photovoltaic cells, fuel cell, heterogeneous catalysis etc.

The thesis, consisting of six chapters and four appendices, dwells upon the above mentioned issues in detail as outlined below.

**Chapter 1: Introduction**

It introduces the theme of the thesis including information about different energy applications of CNTs. It also describes the need and importance of renewable plant based precursors for CNT synthesis.

**Chapter 2: Synthesis of MWCNTs from renewable plant based green precursor.**

This chapter starts with selection of plant precursors from different parts of north-east India. Few suitable plant varieties were screened on the basis of availability, alternative commercial applications and oil content for carbon nanotube synthesis. In the
next section of the chapter the synthesis of catalyst, and development & modification of the CVD setup for synthesis of CNT from plant precursors are discussed in detail.

The morphology and yield of CNTs synthesized from each precursor is carefully analyzed to sort them out based on suitability of each one of these for a particular application envisaged in the thesis.

**Chapter 3: Optimization of process parameters for synthesis of MWCNTs from renewable plant based green precursors using Taguchi Robust Technique.**

This chapter is dedicated to refinement of the process of synthesis by optimizing the process parameters like temperature of synthesis, flow rate of carrier gas, catalyst type and precursor type both for improving yield and quality of MWCNT using Taguchi robust technique

**Chapter 4: Application of functionalized-MWCNTs in organic photovoltaic cells**

The application of MWCNTs synthesized from plant precursors in photovoltaic cells are studied. The chapter also describes a method to cut MWCNTs using simple chemical route.

Finally, the chapter describes the application of the modified MWCNTs in OPVs. The device with functionalized-cut MWCNTs showed best performance.

**Chapter 5: Application of antioxidant grafted MWCNTs in biodiesel storage**

This chapter discusses a new nanomaterial structure which is engineered to contain a magnetic nanoparticle and an antioxidant attached to a substrate. The idea has a potential to make the antioxidant reusable without affecting the performance of the engine.

This chapter also dwells upon the basics of biodiesel storage issues and analyzes the results of experiments which were designed to investigate the efficacy of the antioxidant material system.

**Chapter 6: Conclusion and future work**

This chapter concludes about the strengths and discusses about the scope of improvement in the quality and yield of MWCNTs from plant precursors. The prospects of
utilization and application of MWCNTs for energy systems have been discussed. In this work attempts to provide options for application of MWCNT in energy systems have been made. This chapter discusses the future scope of improvement in the energy systems based on CNTs.

Appendix I: Synthesis of CNTs from waste Polypropylene and Polyethylene terephthalate PET products

A method to utilize solid waste products like Polypropylene (PP) and Polyethylene terephthalate (PET) for synthesis of MWCNT has been explained.

Appendix II: Application of MWCNT in Alkaline fuel cell electrode.

It discusses the results of an attempt to use MWCNT in alkaline fuel cell electrode