Chapter 6
Conclusions and Suggestions for Future Work

6.1 Introduction

This chapter summarizes the thesis work based on the three identified multidisciplinary focus areas of *Solar PV power optimization*, *CSP based crude oil heating applications* and *Carbon Sequestration utilizing Microalgae*.

The major contributions have been outlined in Section 6.2. The suggestions for future work have been reported.

6.2 Contributions and Summary of the Thesis

The present work has dealt with a new approach towards the interdisciplinary research in the areas of sustainability and sustainable development in the Indian Industrial Oil and Gas sector. A path to utilize Solar Energy in conjunction with carbon mitigation has been reported. The thesis also validates the proposed multi-disciplinary methods with the experimental and analytical results obtained from the prototype developed. The major contributions and finding based on three interdisciplinary research work of the thesis conducted have been summarized.

The creation of MATLAB based despatcher control module for solar power generation preciseness and also control grid power. Utilization of Linear Moving Average (MA) model for efficiency improvement and regulating solar power usage has been successfully tested. Effective and efficient results have been achieved for Carbon Capture and Biogas conversion. ***Design of the crude oil heating hybrid system*** in conjunction with Microalgae, Photovoltaic, Concentrated Solar Power and Natural Gas has been successfully developed, demonstrated and evaluated its performance at real industrial locations.

6.3 Suggestions for Future work

It is suggested that improvement of the solar panels power generation ***'preciseness' be analyzed with live weather conditions*** for better and precise consumption propagation module. The despatcher module system may also be developed in C++ or Java language for better equipment switching

cycles. The dispatcher system should be developed using either of the state of art technologies like dSpace, FPGA, DSP and PLC etc.

The proposed ***Hybrid model can be extended for other industrial applications*** like boiler water heating, Pasteurization, Pre-heating water, Thermo-diffusion beams, Sterilization, Distillation, Drying and Blending etc. It is also suggested that the present work can be ***extended utilizing Micro Sterling Engine turbine*** focused on the hot side of the engine which can be utilized to turn heating of hydrogen gas and power the Sterling Engine. This produces direct alternating current power without any additional components and water cooling systems. The CSP hybrid system may be combined with another fuel source of heat like Liquefied Natural Gas (LNG), and Ethanol etc.

The present work has suggested for extension in different industrial sector ***utilizing other sources of biomass*** like agricultural residue, rice husk, grass clipping, no-food crops etc. It is also suggested that Micro-algae based hybrid system need to be explored for the commercialization of 'algae-to-oil' technology for a sustainable business.

Process Integration Process also known as ***"Pinch Analysis"*** is another option for analyzing the optimization of hybrid system operational efficiency. The cost effectiveness of the hybrid system could further analyze utilizing the governmental regulations and financial incentives like ***Clean Development Mechanism (CDM) and Renewable Energy Certificates (REC).***

Last but not least, the ***Energy Storage system*** for Solar thermal system has been proposed for further development to compensate the inherent variability of sunlight. The alternatives on this be further studied utilizing heat transfer fluid, heat resistant oils and molten salt solutions etc.