

Content

Content	i
Abstract	v
List of Figures.....	vii
List of Tables	ix
List of Notations and Acronyms	x
Chapter 1 Introduction and Literature review	11
1.1 Motivation for Renewable Energy.....	11
1.2 Indian Perspective: Renewable Energy, Plans and Scope	12
1.3 Research Proposal Flow chart.....	13
1.4 Major Two Renewable Energy Resources in Indian Oil and Gas sector... 14	
1.4.1 Photo-Voltaic based Solar Electricity and its optimization	14
1.4.2 Concentrated Solar Power based system and applications	15
1.4.3 Algal-Biomass system: Carbon Sequestration.....	16
1.5 Solar Energy and their Classifications	16
1.6 Advantages / Disadvantages of PV based Solar Energy	17
1.7 Literature Review.....	18
1.8 Motivation for Research and Problem Statement	24
1.9 Road Map of the Thesis	24
1.10 Thesis Contributions	26
1.11 Conclusion	26
Chapter 2 Role of Renewable Energy and its Classifications	27
2.1. Introduction	27
2.2. Role of Solar Energy	27
2.2.1. Mathematical Modeling of PV cell/ Module/Array.....	27
2.2.2. Five Parameters based Single Diode Model	29

2.2.3. Temperature and Radiation Effects	31
2.2.4. DC-DC converters	33
2.2.5. Cuk Converter Topology	34
2.2.6. Role of Maximum Power Point Tracking Techniques	35
2.2.6.1 Perturb and Observe Algorithm.....	36
2.2.6.2 Incremental Conductance (INC) method.....	37
2.2.1. State Space analysis of Cuk Converter control	40
2.2.2. MATLAB Simulation of PV Module	43
2.3. Commercial application of Concentrated Solar Power (CSP).....	46
2.4. Microalgae application for Carbon Sequestration.....	47
2.5. Conclusions	47
Chapter 3 Utilization of Solar Energy and Bio-Energy in Oil industry.....	48
3.1 Introduction	48
3.2 Solar Energy Optimization at Captive Power Plant-Assam	48
3.2.1. Description of the Control system.....	49
3.2.2. Solar Plant Energy Generation Prognosis.....	50
3.2.3. Experimental analysis for Height and Azimuth angles	55
3.2.4. Influence of Sun Angles for Solar system output	57
3.2.5. Effect of Dust, Clouds and Rain on the panel output.....	58
3.2.6. Module realization description.....	60
3.2.7. Power Consumption Propagation.....	61
3.2.8. Dispatcher Module Design	62
3.3 Substitution of NG with CSP for Crude Oil Heating Applications	64
3.3.1. Research Concept and Platform.....	64
3.4 Bio-fixation of CO ₂ with microalgae in Oil Sector in India	66
3.5 Conclusions	69

Chapter 4 Research Methodology for Crude Oil Heating in Conjunction with PV, CSP and Microalgae	70
4.1. Introduction	70
4.2. CSP technology and Natural Gas system	70
4.2.1. Research Methodologies	71
4.3. Algal- Solar (PV & CSP)-NG hybrid system.....	73
4.4. Research Partners & Funding.....	77
4.5. Techno-commercial analysis of Bio-Solar-NG hybrid system	78
4.6. Conclusion	80
Chapter 5 Model Validation, MATLAB Simulation and Results	81
5.1 Introduction	81
5.2 Solar PV optimization and Validation	81
5.2.1. Design of CUK Converter	82
5.2.2. MATLAB Simulation of PV modeling at Location 1	83
5.2.3. Despatcher module description	85
5.3 Crude Oil Heating applications utilizing CSP Technology.....	92
5.4 Crude Oil heating applications utilizing Bio-Solar hybrid	95
5.5 Alternate options for Crude Oil Heating and Comparison	98
5.6 Comparative analysis between alternative solutions	98
5.7 Techno-Economic analysis of Bio-NG-PV-hybrid system.....	99
5.8 Summary and Conclusions	102
Chapter 6 Conclusions and Suggestions for Future Work	103
6.1 Introduction	103
6.2 Contributions and Summary of the Thesis	103
6.3 Suggestions for Future work.....	103
References.....	105
Appendices	111

Appendix A: DC-DC Converter family.....	111
Appendix B: MATLAB Program for Energy generation prognosis	112
Appendix C: Typical crude oil treatment system.....	116
Appendix D: Anaerobic digesters for on-site carbon capture and biogas.....	117
List of Publications	118
Journals.....	118
Conferences / Seminar	118
Personal profile.....	120