

CONTENTS

| | Page no. |
|--|------------|
| LIST OF FIGURES | iii |
| LIST OF TABLES | v |
| LIST OF ABBREVIATIONS | vi |
| | |
| CHAPTER 1: INTRODUCTION | 1 |
| 1.1 Power Scenario in India | 1 |
| 1.2 Power Scenario in North-Eastern Region | 2 |
| 1.3 Renewable Energy Scenario in India | 2 |
| 1.3.1 Solar Power | 2 |
| 1.3.2 Wind Power | 3 |
| 1.3.3 Small Hydro Power | 3 |
| 1.4 India's Energy Policies | 3 |
| 1.4.1 National Electricity Policy 2005 | 3 |
| 1.4.2 The Electricity Act 2003 | 3 |
| 1.4.3 Tariff Policy, 2006 | 4 |
| 1.4.4 National Rural Electrification Policies 2006 | 4 |
| 1.4.5 Integrated Energy Policy Report | 5 |
| 1.5 Decentralized energy | 5 |
| 1.6 Difference between Centralized and Decentralized Energy | 5 |
| 1.7 Decentralized electricity generation and rural development | 6 |
| 1.8 Renewable Energy based DG Technologies | 6 |
| 1.8.1 Wind Energy | 6 |
| 1.8.2 Photovoltaic System | 7 |
| 1.8.3 Biomass Gasification System | 7 |
| 1.9 HOMER (Hybrid Optimization Model for Electric Renewable) | 8 |
| | |
| CHAPTER 2: REVIEW OF LITERATURE | 9 |

| | |
|---|-----------|
| CHAPTER 3: OBJECTIVES AND METHODOLOGY | 13 |
| 3.1 Objectives | 13 |
| 3.2 Methodology | 13 |
| 3.2.1 Study Area | 13 |
| 3.2.2 HOMER simulation tool | 14 |
| 3.2.3 Village load assessment | 17 |
| 3.2.3.1 Resource Assessment | 17 |
| 3.2.4 Comparison tool | 17 |
| | |
| CHAPTER 4: RESULTS AND DISCUSSION | 18 |
| 4.1 Village load assessment | 18 |
| 4.2 Solar Energy Resources | 24 |
| 4.3 Biomass resource | 25 |
| 4.4 Components assessment | 25 |
| 4.4.1 Solar Photovoltaic system | 25 |
| 4.4.2 Biomass gasification system | 26 |
| 4.4.3 Battery | 28 |
| 4.4.4 Converter | 28 |
| 4.4.5 Optimizing Schedule | 28 |
| 4.4.6 Sensitivity input | 30 |
| 4.4.7 Economic input | 30 |
| 4.4.8 Constraints | 31 |
| 4.5 Simulation results analysis | 32 |
| 4.5.1 Optimization results | 32 |
| 4.5.1.1 Sensitivities with biomass price | 32 |
| 4.5.1.2 Sensitivities with biomass gasifier capital cost | 35 |
| 4.5.1.3 Sensitivities with PV capital cost | 37 |
| 4.5.1.4 Optimized system configurations | 39 |
| | |
| CHAPTER 5: CONCLUSIONS | 41 |
| | |
| REFERENCES | 43 |
| | |
| ANNEXURE I (Part 1 Village Schedule, Part 2: Household schedule) | 46 |

LIST OF FIGURES

| Figure | Particulars | Page No. |
|--------|--|----------|
| 1.1 | Off-grid photovoltaic system | 8 |
| 1.2 | Off-grid biomass gasification system | 8 |
| 3.1 | Relationship between simulation, optimization and sensitivity analysis | 15 |
| 3.2 | Framework for off-grid electricity generation with HOMER analysis | 16 |
| 3.3 | Selected load components | 16 |
| 4.1 | Daily hourly load pattern for Option A | 19 |
| 4.2 | Monthly load pattern for Option A | 20 |
| 4.3 | Daily hourly load pattern for Option B | 21 |
| 4.4 | Monthly load pattern for Option B | 21 |
| 4.5 | Daily hourly load pattern for Option C | 22 |
| 4.6 | Daily hourly load pattern for Option D | 23 |
| 4.7 | Monthly load pattern for Option C | 24 |
| 4.8 | Monthly load pattern for Option D | 24 |
| 4.9 | Solar radiation profile | 25 |
| 4.10 | Solar photovoltaic technical and cost parameter | 26 |
| 4.11 | Biomass gasification system technical and cost parameter | 27 |
| 4.12 | Design of various loads and energy generation systems | 27 |
| 4.13 | Battery technical and cost parameter | 28 |
| 4.14 | Converter technical and cost parameter | 29 |
| 4.15 | Equipment search space for different sizes considered for Option A | 29 |
| 4.16 | Sensitivity input | 30 |
| 4.17 | Economic Input | 31 |
| 4.18 | Simulation constraints Input | 31 |
| 4.19 | Biomass Price vs. cost of energy for Option A (19kW) | 33 |
| 4.20 | Biomass Price vs. cost of energy for Option B (21kW) | 33 |
| 4.21 | Biomass Price vs. cost of energy for option D (24kW) | 34 |
| 4.22 | Biomass Price vs. cost of energy for option C (41kW) | 34 |
| 4.23 | BG capital cost vs. cost of energy for option A (19kW) | 35 |
| 4.24 | BG capital cost vs. cost of energy for option A (21kW) | 35 |
| 4.25 | BG capital cost vs. cost of energy for option A (24kW) | 36 |
| 4.26 | BG capital cost vs. cost of energy for option A (41kW) | 36 |

| | | |
|------|--|----|
| 4.27 | PV capital cost vs. cost of energy for option A (19kW) | 37 |
| 4.28 | PV capital cost vs. cost of energy for option A (21kW) | 37 |
| 4.29 | PV capital cost vs. cost of energy for option A (24kW) | 38 |
| 4.30 | PV capital cost vs. cost of energy for option A (41kW) | 38 |
| 4.31 | Optimized configuration for best options and second best options for Various loads of the village | 40 |

LIST OF TABLES

| Table | Particulars | Page No. |
|-------|---|----------|
| 1.1 | State Wise Percentage of Un-electrified villages of NE region | 6 |
| 3.1 | Jhawani village details | 14 |
| 4.1 | Load analysis for Option A | 19 |
| 4.2 | Load analysis for Option B | 20 |
| 4.3 | Load analysis for Option C | 22 |
| 4.4 | Load Analysis for Option D | 23 |
| 4.5 | Monthly average Solar Radiation | 25 |
| 4.6 | Simulation results | 32 |
| 4.7 | Optimized system configuration for different peak loads | 39 |

LIST OF ABBREVIATIONS

| | |
|-------|--|
| ALCC | Annualized Life Cycle Cost |
| COE | Cost of Energy |
| CRF | Capital Recovery Factor |
| BG | Biomass Gasification System |
| DG | Decentralized Generation |
| HOMER | Hybrid Optimization Model for Electric Renewable |
| RES | Renewable Energy Source |
| SHP | Small Hydro Plant |
| SPV | Solar Photovoltaic |