

LIST OF FIGURES

Figure-1	Global and Diffuse solar radiation	Page-5
Figure- 2	Spectral PV device's response	Page-6
Figure-3.a	Annual global solar radiations	Page-8
Figure-3.b	Solar energy availability in India	Page-9
Figure-4	Global cumulative capacity of solar PV energy	Page-10
Figure-5	Solar cells	Page-12
Figure-6	Technology of Solar PV system	Page-12
Figure-7	Power Vs wind Velocity	Page-18
Figure-8	Depth of discharge of the lead acid battery	Page-24
Figure-9	PIC microcontroller based solar wind hybrid system	Page-31
Figure-10	Designing procedure of the charge controller	Page-32
Figure-11	DC Voltage regulator	Page-33
Figure-12	WCS1702 current Sensor	Page-34
Figure-13	Testing of current sensor at different loads in the laboratory	Page-35
Figure-14	24CO4 EEPROM	Page-36
Figure-15	Logic diagram of EEPROM 24CO4	Page-37
Figure-15.1	Schematic diagram of EEPROM with microcontroller	Page-38
Figure-16	Pin configuration of MC34063A	Page-45
Figure-17	Timing Capacitance Vs off-time	Page-46
Figure-18	Vosc Vs time division	Page- 46
Figure-19	Emitter current Vs saturation Voltage	Page-46
Figure-20	Collector current Vs Saturation voltage	Page-46

Figure-21.a	Circuit diagram of DC-DC boost converter	Page-47
Figure-21.b	DC-DC boost converter on PCB.	Page-48
Figure-22	Basic layout of a microcontroller	Page-49
Figure-23	PIC16F877A pin configuration	Page-55
Figure-24	PIC based charge controller	Page-57
Figure-25	16× 2 LCD display	Page-62
Figure-26	Circuit diagram of LCD Display	Page-66
Figure-27	Microcontroller interface with relay	Page-67
Figure-28	Schematic circuit diagram of DC- DC boost converter	Page-69
Figure-29	Solar radiations Vs time	Page-72
Figure-30	Solar radiation Vs solar module voltage	Page-72
Figure-31	Battery charging w.r.t time (during the load)	Page-73
Figure-32	Battery discharging rates w.r.t time (during the load)	Page-74
Figure-33	Battery Overcharging rate w.r.t time (during the load)	Page-75
Figure-34	Wind speed Vs time	Page-76
Figure-35	Wind speed Vs wind turbine output voltage	Page-76
Figure-36	Battery charging rates with respect to the time (during the load)	Page-77
Figure-37	Battery discharging rate with respect to the time (during the load)	Page-78
Figure-38	Battery overcharging rates w.r.t time (during the load)	Page-79

LIST OF TABLES

Table -1	Logic signal	Page-37
Table-2	Testing components and their specifications	Page-39
Table-3	Operating Conditions of solar wind hybrid systems	Page-43
Table-4	Key Features of PIC16F877A microcontroller	Page-53
Table-5	Alternate functions of the PIC16F877A microcontroller	Page-55
Table-6	Key board shortcuts available in mikroC for PIC IDE	Page-60
Table-7	Pin Configurations of LCD	Page-63

LIST OF ABBREVIATIONS

Btu	British thermal unit
OECD	Organization for Economic Co-operation and Development
WMO	World Meteorological Organization
AM	Air Mass
NREL	National Renewable Energy Laboratory
IMMP	Maximum Power Point Current
VMMP	Maximum Power Point Voltage
CASE	Commission for Additional Energy Sources
SOC	State Of Charge
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
PWM	Pulse Width Modulation
HAWT	Horizontal Axis Wind Turbine
VAWT	Vertical Axis Wind Turbine
HVAWT	Horizontal and Vertical Axis Wind Turbine
HRES	Hybrid Renewable Energy System
PIC	Programmable Intelligent Controller / Peripheral Interface Controller
EEPROM	Electrically Erasable Program Only Memory
ROM	Random Only Memory

EECON	Electrically Erasable Conversion
CPU	Central Processing Units
EEDATA	Electrically Erasable Data
LCD	Liquid Crystal Display
PCB	Printed Circuit Board
MCLR	Master Clear input
OSC	Oscillator
USART	Universal Asynchronous Receiver Transmitter
ADC	Analog to Digital Converter
POR	Power On Reset
PWRT	Power up Timer
OST	Oscillator Start-up Timer
WDT	Watchdog Timer
CMOS	Complementary Metal Oxide Semiconductor

ICSP	In Circuit Serial Programming
SSP	Synchronous Serial Port
PSP	Parallel Slave Port
BOR	Brown-Out Reset
ICD	In Circuit Debugger
HEX	Hexadecimal
SFR	Special Function Register
ASCII	American Standard Code for Information Interchange
CAN	Controller Area Network
SPI	Serial Peripheral Interface

CONTENTS

Declarations	I
Acknowledgement	II
Abstract	III
Table of contents	IV
List of figures	V
List of Tables	VI
List of Abbreviations	VII
1. Introduction	1
1.1. World Energy Demand	2
1.2. Renewable energy	3
1.3. Solar Energy	3
1.3.1 Solar radiation	4
1.3.2 Solar radiation related with angle of geometry	7
1.4. Photovoltaic Technology	11
1.5. Wind energy	14
1.6. Hybrid systems	19
1.7. Battery	19
1.7.1. Battery state of charge	20
1.7.2. Floating charge of the battery	21
1.7.3. Battery life time	21
1.8. Charge Controller	24
1.9. DC-DC Converter	25
2. Literature review	27-29

3. Methodology	30
3.1. Testing of Current Sensor in the laboratory at difference load conditions	33-35
3.2. Testing of EEPROM	35-40
4. Designing of Control Units	41
4.1. DC-DC boost converter	44
4.1.1. Pin descriptions	45
4.1.2. Electrical characteristics	46-47
4.1.3. Functional descriptions of MC34063	47-48
4.2. Charge controller	48
4.3. What is microcontroller?	49-50
4.3.1. General features of PIC16F877A	51
4.3.1.1. Microcontroller core features	51
4.3.1.2. Peripheral Feature of PIC Timer0	52-57
4.4. Mikro C	57
4.4.1. Features	57-58
4.4.1.1 Code explorer	59
4.4.1.2 Mikro ICD	59-61
4.5. LCD	62-66
4.6. Relay	66-67
5. Result and discussion	68
5.1. Economic models of hybrid system	79
5.1.1 Annualized capital cost	79-81
5.1.2. Annualized replacement cost	81
5.1.3. Annualized maintenance cost	81

6. Conclusion and future scope	82
6.1. conclusion	83
6.2.Future scope	83
7. References	84-87
8. Appendix	87-99