

LIST OF CONTENT

Chapter	Page
I INTRODUCTION	1
Rationale for the Study and Statement of the Problem.....	1
Objectives of the study.....	3
Scope of the study	3
Keywords or Definition Term.....	4
Benefits of the study	4
II LITERATURE REVIEW	5
Photovoltaic System	5
PV Modules Degradation	7
Summary of literature review.....	12
III RESEARCH METHODOLOGY	15
Literature Review	17
Selection of samples.....	17
Data Collection	18
Review of name plate data and Manufacturer's data sheets.....	18
Equipment used for I-V curve measurement.....	21
Testing of selected modules under field conditions.....	23
Correction of measured values to STC values.....	27
Calculation of Degradation.....	32

LIST OF CONTENT (CONT.)

Chapter	Page
IV RESULTS AND DISCUSSION	33
Impact of long term weathering on basic electrical parameters.....	33
Performance in terms of Efficiency.....	40
Results and Guarantee conditions.....	40
Comparison with past researches.....	43
Degradation modes.....	43
V CONCLUSION AND RECOMMENDATION.....	47
Conclusion	47
Recommendations	47
REFERENCES.....	48
APPENDIX.....	55
BIOGRAPHY.....	62

LIST OF TABLES

Table		Page
1	Details of PV modules under study	3
2	Types of solar cell technologies and their efficiencies.....	5
3	Degradation in c-Si Modules.....	9
4	Summary of percentage degradation Rate per annum in PV modules	13
5	Equipment used for I-V curve measurement	21
6	Different methods for correction of measured I-V curve data sets of PV modules to STC.....	28
7	Module performance data and %change with respect to name plate	33
8	Comparasion between nominal and present Efficiency for 4 lots of modules	40
9	Summary of P_{max} and annual variation rates	41

LIST OF FIGURES

Figure	Page
1	Typical spectral response of different thin film technologies and AM 1.5 spectral distribution..... 8
2	Flow chart of research methodology..... 16
3	Monthly maximum, minimum and average temperatures (representative year 2010) for SERT Phitsanulok..... 19
4	Monthly maximum, minimum and average relative humidity (representative year 2010) for SERT Phitsanulok..... 20
5	Monthly maximum, minimum and average wind speed at 3 meter height (representative year 2010) for SERT Phitsanulok..... 20
6	PV modules Lot I, II & III installations at SERT Energy Park NU Phitsanulok..... 23
7	PV modules Lot IV installations at SERT Energy Park NU Phitsanulok..... 23
8	Single line diagram of I-V curve measurement system..... 24
9	Typical I-V curve characteristics..... 25
10	I-V curve characteristics at constant temperature and varying irradiances..... 26
11	I-V curve characteristics at constant irradiance and va temperatures.... 27
12	Sample Snapshot of series resistance (R_s) calculation through Sandia software..... 32
13	Corrected P_{max} vs Nominal P_{max} along with the period under operation for samples selected from Lot I. 35
14	Corrected P_{max} vs Nominal P_{max} along with the period under operation for samples selected from Lot II. 35
15	Corrected P_{max} vs Nominal P_{max} along with the period under operation for samples selected from Lot III. 36
16	Corrected P_{max} vs Nominal P_{max} along with the period under operation for samples selected from Lot IV. 36

LIST OF FIGURES (CONT.)

Figure		Page
17	Corrected I-V curves for selected modules from Lot I samples.....	37
18	Corrected I-V curves for selected modules from Lot II samples.....	38
19	Corrected I-V curves for selected modules from Lot III samples.....	38
20	Corrected I-V curves for selected modules from Lot IV samples.	39
21	Comparison showing actual variations against warrantee for LOT I, II, III & IV modules.	42
22	Discoloring at the center of each cell in almost all of the modules belonging to Lot I.	44
23	Discoloring pattern for Lot I modules, partial development is visible on right side module.	44
24	Discoloring pattern for Lot II modules, cell at center bottom is in original condition while others are darker.	45
25	Discoloring pattern for Lot IV modules, cell central area has color change.	45
26	Lot III modules, no noticeable discoloring found.	46