

HIGHER TECHNICAL INSTITUTE

Nicosia – Cyprus

ELECTRICAL ENGINEERING COURSE

DIPLOMA PROJECT

SOLAR PHOTOVOLTAIC SYSTEMS

BY

TZIAKOURIS KYPROS

E.1322

JUNE 2003

HIGHER TECHNICAL INSTITUTE	PROJECT NO. 3403
----------------------------------	-------------------------

SOLAR PHOTOVOLTAIC SYSTEMS

Project Report submitted by:

Tziakouris Kypros

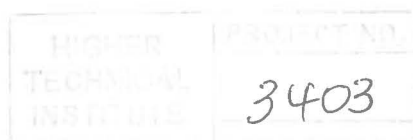
**In part of satisfaction to the conditions for the award of
diploma Technical Engineering in Electrical Engineering
of the Higher Technical Institute, Cyprus.**

Project Supervisor: Dr C. Marouchos

Lecturer in Electrical Engineering H.T.I

Type of Project: Individual

June, 2003



ACKNOWLEDGMENTS

I would like to express my sincere appreciation to my project supervisor Dr. C. Marouchos lecturer in the Electrical Department of the Higher Technical Institute for all of his help, especially in the collection of the information, for his advice and also for his patience with me.

LIST OF CONTENTS

INTRODUCTION	1
CHAPTER 1: RENEWABLE ENERGY	
1.1 Types of renewable energy	2
1.2 Benefits of renewable energy	4
1.3 Renewable energy and EU	5
CHAPTER 2: SOLAR, PHOTOVOLTAIC ENERGY	
2.1 Solar radiation	7
2.2 Solar radiation in Cyprus	8
2.3 The physics of solar cells	11
2.4 The photovoltaic effect	12
2.5 Analysis of photovoltaic cell	14
2.6 Maximum output potential during day	16
2.7 PV cells, modules, arrays	16
2.8 Manufacture of photovoltaic cells	17
CHAPTER 3: INVERTRES	
3.1 Inverter mode converter	20
3.2 Inverters using PWM	21
3.2.1 PWM	21
3.2.2 Single phase inverters	22
3.3 Photovoltaic interface	23
CHAPTER 4: PHOTOVOLTAIC SYSTEMS	
4.1 Merits of Photovoltaic systems	25
4.2 Limitations of photovoltaic systems	25

4.3 Major components in a PV system	26
4.4 How are photovoltaic systems classified?	26
4.5 Grid-connected photovoltaic systems	27
4.5.1 Grid-inverters	27
4.6 Stand-alone photovoltaic systems	29
4.6.1 Batteries	30
4.6.2 Stand-alone inverter	31
4.7 Some other Photovoltaic systems	31

CHAPTER 5: EQUIPMENT THAT HAVE BEEN USED FOR THE REAL SYSTEMS

5.1 Inverters	35
5.1.2 Specifications and functions of the Mastervolt inverter.	35
5.1.3 Questions and Answers on inverters- Mastervolt Technical Information	37
5.2 Batteries	38
5.2.1 Kind of batteries	38
5.2.2 Battery interconnection	38
5.2.3 Battery bank ratings and sizing	38
5.2.4 Determination of service life	38
5.2.5 Questions and answers on battery- Mastervolt Technical information	39
5.3 Photovoltaic modules	41
5.3.1 Characteristics	41
5.3.2 Performances	41
5.4 Fronius inverters that use in grid-connected systems.	43

CHAPTER 6: PRESENT A REAL SYSTEM

6.1 A real stand-alone system	45
6.2 The conversion of the stand-alone system to a grid-connected system	50
6.2.1 PART A: convert the system without adding new PV modules	50
6.2.2 PART B: Convert the system with adding new PV modules	51
CONCLUSIONS	54

GLOSSARY OF TERMS

55

REFERENCES

56

EAC REGULATIONS

57

INDRODUCTION

The main objective of this project is to investigate and present a real photovoltaic system and overview the prospect ivies that such a system has in Cyprus.

In order to fulfill the objectives the following approach was followed.

- A briefly description of the benefits and types of renewable energy
- Analysis of solar, photovoltaic, energy – solar radiation, photovoltaic panels.
- The performance characteristic of each component use in PV systems – inverters, batteries.
- Presentation of real systems, including an economical investigation to see if PV systems are economical feasible in Cyprus.

The project offers practically any information a person may need about photovoltaic systems. There are documents, pictures, drawings, manufactures specifications and even EAC regulations that allow the reader to get a complete picture of a photovoltaic system.