

Design optimisation and costing analysis
of a
renewable energy hydrogen system

by

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ABSTRACT

The South African Department of Science and Technology is striving to develop a means of producing hydrogen gas in remote and civil areas through the use of renewable energy sources. For the purposes of creating such mobile hydrogen production facilities, a small-scale hydrogen production system based on renewable energy sources needs to be developed and modelled. This system is to serve as a pilot plant for further development of a large scale mobile hydrogen production facility.

This work focuses on the characterisation of sizing algorithms for renewable energy sources which can determine component configurations that satisfy power requirements of the system. Additionally, optimal sizing techniques must be developed which can output an optimal plant configuration to a user based on cost and efficiency.

To this end, a literature study was done on all the components that make up a renewable energy hydrogen system. The techniques researched were then applied to create algorithms capable of correctly sizing the required components of such a plant. These techniques were integrated into an application created in the LabVIEW environment, which is capable of outputting an optimal plant configuration based on the specific needs of a client.

A case study was defined with which the results of the simulation models were verified. Using this work, a future, more comprehensive system may be developed and commercialised, building from the techniques implemented here.

KEYWORDS

Renewable Energy, Optimal sizing, LabVIEW, Hybrid Hydrogen System, Costing Analysis.

DECLARATION

I, **Rudolph Petrus Louw** declare herewith that this thesis, entitled "**Design optimisation and costing analysis of a renewable energy hydrogen system**", which I herewith submit to the North-West University as partial completion of the requirements set for the **Master of Engineering** degree, is my own work and has not been submitted to any other university.

I understand and accept that the copies that are submitted for examination are the property of the University.

Signature of candidate: _____

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Signed at: **Potchefstroom** this 27th day of November 2012.

TABLE OF CONTENTS

ABSTRACT	II
KEYWORDS	II
DECLARATION	III
TABLE OF CONTENTS	IV
LIST OF FIGURES	VII
LIST OF TABLES	IX
LIST OF ABBREVIATIONS	X
CHAPTER 1 - INTRODUCTION	1
1.1 BACKGROUND	1
1.2 SOFTWARE REQUIREMENTS	2
1.3 RESEARCH OVERVIEW	3
1.3.1 <i>Software development methodology</i>	3
1.3.2 <i>Research context</i>	5
1.3.3 <i>Research outcomes</i>	7
1.4 ORGANISATION	8
CHAPTER 2 - LITERATURE STUDY	9
2.1 PHOTOVOLTAIC POWER SYSTEMS	9
2.1.1 <i>Introduction</i>	9
2.1.2 <i>Photovoltaic modules</i>	11
2.1.3 <i>Photovoltaic arrays</i>	15
2.1.4 <i>Output converter topologies</i>	15
2.2 WIND POWER SYSTEMS	19
2.2.1 <i>Introduction</i>	19
2.2.2 <i>Wind turbine design</i>	19
2.2.3 <i>Wind turbine integration</i>	20
2.3 SENSORY APPARATUS	21
2.3.1 <i>Introduction</i>	21
2.3.2 <i>Solar irradiance</i>	22
2.3.3 <i>Wind speed</i>	23
2.3.4 <i>Temperature</i>	24
2.3.5 <i>Humidity</i>	24
2.4 SYSTEM OPTIMISATION	25
2.4.1 <i>Metaheuristic approach</i>	25

TABLE OF CONTENTS

2.5	REVIEW	26
CHAPTER 3 - DESIGN CONCEPT		27
3.1	SYSTEM OVERVIEW	27
3.1.1	<i>Functional Architecture</i>	28
3.2	FUNCTIONAL FLOW & BLOCK DEFINITION.....	30
3.2.1	<i>Application I/O: F/U1.1</i>	30
3.2.2	<i>Renewable-energy sizing procedures: F/U1.2</i>	30
3.2.3	<i>Iterative System Economic Analysis Procedures: F/U1.3</i>	33
3.2.4	<i>System Outputs: F/U1.4</i>	34
3.3	REVIEW	35
CHAPTER 4 - DEVELOPMENT		36
4.1	REHS COMPONENT SIZING	36
4.1.1	<i>Introduction</i>	36
4.1.2	<i>Meteorological Data Retrieval</i>	37
4.1.3	<i>Solar Systems</i>	37
4.1.4	<i>Wind Systems</i>	44
4.1.5	<i>Weather Station</i>	50
4.1.6	<i>Storage System</i>	50
4.1.7	<i>Electrolyser</i>	51
4.2	OPTIMISATION PROCEDURE	51
4.2.1	<i>Objective function</i>	52
4.2.2	<i>Main algorithm</i>	55
4.2.3	<i>Secondary algorithm</i>	57
4.2.4	<i>Tertiary algorithm</i>	59
4.3	IMPLEMENTATION OF THE OPTIMISATION PROCEDURE.....	61
4.4	CHAPTER REVIEW	62
CHAPTER 5 - TESTING AND VALIDATION		63
5.1	TESTING METHODOLOGY	63
5.2	EXTERNAL SOFTWARE	64
5.2.1	<i>HOMER</i>	64
5.2.2	<i>Rentech</i>	64
5.3	CASE STUDY.....	65
5.3.1	<i>Renewable energy requirements</i>	65
5.4	APPLICATION DESCRIPTION	67
5.4.1	<i>Front Panel</i>	67
5.4.2	<i>Wind turbine configuration</i>	69
5.4.3	<i>PV array configuration</i>	72

TABLE OF CONTENTS

5.4.4	<i>Output Storage</i>	75
5.4.5	<i>Weather station</i>	76
5.4.6	<i>Auxiliary systems</i>	77
5.4.7	<i>Electrolyser configuration</i>	78
5.5	SCENARIO EVALUATION.....	79
5.5.1	<i>Scenario 1 – Wind turbine sizing</i>	79
5.5.2	<i>Scenario 2 – PV array sizing</i>	89
5.5.3	<i>Scenario 3 – ESM Optimised configuration (Non-GA)</i>	99
5.5.4	<i>Scenario 4 – ESM optimised configuration (GA)</i>	105
5.6	REVIEW	109
CHAPTER 6 - CONCLUSION		110
6.1	SUMMARY OF WORK.....	110
6.2	RESEARCH OUTCOMES.....	112
6.2.1	<i>Solar and wind energy integration</i>	112
6.2.2	<i>System configuration optimisation</i>	113
6.3	INTEGRATION RESULTS.....	113
6.4	FUTURE WORK.....	114
6.4.1	<i>Module expansion</i>	114
6.4.2	<i>Verification</i>	114
6.5	IN SUMMARY	114
REFERENCES		115
APPENDIX A		119

LIST OF FIGURES

Figure 1.1 – Idealised software development procedure [3]	3
Figure 1.2 – Example of an incremental development life-cycle model [5].....	4
Figure 1.3 – REHS System definition.....	5
Figure 2.1 – Exploded view of a solar array [9].....	10
Figure 2.2 – I-V characteristic curve of a typical PV module.....	11
Figure 2.3 – PV Array example	15
Figure 2.4 – Three types of PV inverter topologies [19].....	18
Figure 2.5 – Major components of the HAWT [25].....	20
Figure 2.6 – Kipp & Zonen pyranometer	22
Figure 2.7 – (a) Combination of wind speed and wind direction sensors. (b) Ultrasonic wind sensor..	23
Figure 3.1 – Application functional architecture	28
Figure 3.2 – Functional Flow Diagram for F/U1.1	31
Figure 3.3 – Functional Flow Diagram for F/U1.2	32
Figure 3.4 – Functional Flow Diagram for F/U1.3	34
Figure 3.5 – Functional Flow Diagram for F/U1.4	35
Figure 4.1 – PV Modules and PV array sizing parameters	38
Figure 4.2 – PV inverter sizing parameters	38
Figure 4.3 – Diagrammatical pseudo-code for PV array sizing.....	43
Figure 4.4 – Wind turbine sizing parameters.....	44
Figure 4.5 – WT inverter/converter sizing parameters	45
Figure 4.6 – Diagrammatical pseudo-code for wind turbine array sizing	49
Figure 4.7 – Diagrammatical pseudo-code for weather station components array sizing	50
Figure 4.8 – Main algorithm chromosome construction	55
Figure 4.9 – Individual row value consignment from parameters in the appropriate database	56
Figure 4.10 – Secondary algorithm chromosome construction.....	57
Figure 4.11 – Tertiary algorithm chromosome construction.....	59
Figure 4.12 – Diagrammatical pseudo-code for genetic algorithm implementation	61
Figure 5.1 – ESM Front Panel	67
Figure 5.2 – WT Configuration Interface	69
Figure 5.3 – First WT Selection Set – Manufacturer Selection	69
Figure 5.5 – WT Selection – Distance specification.....	70
Figure 5.4 – WT Information Set – Turbine Database View.....	70
Figure 5.6 – WT Information Set – Probable Wind Speed	71
Figure 5.7 – WT Information – Connection philosophy	72
Figure 5.8 – PV Configuration Interface	72
Figure 5.9 – First PV Selection Set – Manufacturer Selection	73
Figure 5.10 – PV Selection – Distance specification.....	73
Figure 5.11 – PV Information Set – Irradiance	74

LIST OF FIGURES

Figure 5.12 – PV Information – Connection philosophy 75

Figure 5.13 – Output Storage configuration 75

Figure 5.14 – Weather Station configuration 76

Figure 5.15 – Auxiliary System configuration 77

Figure 5.16 – Electrolyser Specification 78

Figure 5.17 – Wind System Cost Comparison 84

Figure 5.18 – PV Array System Cost Comparison 93

Figure 5.19 – Non-GA Optimisation Procedure..... 102

Figure 5.20 – Restructured GA implementation methodology 106

LIST OF TABLES

Table 5.1 – Case study requirements summary	66
Table 5.2 – Wind turbine model summary.....	80
Table 5.3 – Wind turbine inverter summary	81
Table 5.4 – Truncated Wind turbine sizing results – General power outputs.	81
Table 5.5 – Truncated wind turbine inverter sizing results – General power outputs.	81
Table 5.6 – Total wind turbine system costs using general power inputs.....	82
Table 5.7 – Procedure execution time (General wind turbine power inputs)	82
Table 5.8 – Truncated wind turbine sizing results – TSM-specified power outputs.....	82
Table 5.9 – Truncated wind turbine inverter sizing results – TSM-specified outputs.....	83
Table 5.10 – Total WT system costs using TSM-specified power inputs.....	83
Table 5.11 – Procedure execution time (TSM-specified wind turbine power inputs).....	83
Table 5.12 – Execution time differences using general power inputs vs. TSM power inputs	85
Table 5.13 – Component selection for analytical comparison.....	85
Table 5.14 – ESM WT sizing results vs. Analytical WT sizing results	88
Table 5.15 – ESM WT costing results vs. Analytical WT costing results	88
Table 5.16 – PV module model summary	89
Table 5.17 – PV array inverter summary.....	90
Table 5.18 – Truncated solar sizing results – General power outputs.....	90
Table 5.19 – Truncated Inverter Sizing results – General power outputs.....	91
Table 5.20 – Total WT system costs using general power inputs.....	91
Table 5.21 – Procedure execution time (General wind turbine power inputs)	91
Table 5.22 – Truncated PV module sizing results – TSM-specified power outputs.....	92
Table 5.23 – Truncated inverter sizing results – TSM-specified outputs.	92
Table 5.24 – Total PV system costs using TSM-specified power inputs.	92
Table 5.25 – Procedure execution time (TSM-specified PV module power inputs).....	93
Table 5.26 – Execution time differences using general power inputs vs. TSM power inputs	94
Table 5.27 – Component selection for analytical comparison.....	95
Table 5.28 – PV module technical specifications.....	95
Table 5.29 – PV inverter technical specifications.....	95
Table 5.30 – ESM PV sizing results vs. Analytical PV sizing results	99
Table 5.31 – ESM PV costing results vs. Analytical PV costing results.....	99
Table 5.32 – Exact optimal solution as determined by the ESM (non-GA).....	103
Table 5.33 – Complete sizing results (non-GA) for an REHS-based plant.....	104
Table 5.34 – Execution time for determining the exact optimal solution for case study (Non-GA).....	104
Table 5.35 – Optimal solution (GA) for renewable energy systems.....	108
Table 5.36 – Execution time for determine the exact optimal solution for case study (non-GA vs. GA)	108

LIST OF ABBREVIATIONS

AC	-	Alternating Current
DC	-	Direct Current
DST	-	Department of Science and Technology
ESM	-	Economic Simulation Model
F/U	-	Functional Unit
FF	-	Fill Factor (Solar Module Efficiency)
GA	-	Genetic Algorithm
HAWT	-	Horizontal Axis Wind Turbine
HOMER	-	Hybrid Optimization Model for Electric Renewables
HVAC	-	Heating, Ventilation and Air Conditioning
I/O	-	Input/Output
I-V	-	Current-Voltage
LHC	-	Large Hadron Collider
MPPT	-	Maximum Power Point Tracker
PAT	-	Power Allocation Table
PDF	-	Probability Density Function
PV	-	Photovoltaic
REHS	-	Renewable Energy Hydrogen System
STC	-	Standard Test Conditions
		<i>irradiance = 1000 Watt per square meter ($kW \cdot m^{-2}$)</i>
		<i>module temperature = 25 degrees Celcius ($^{\circ}C$)</i>
TSM	-	Technical Simulation Model
VI	-	Virtual Instrument
WASA	-	Wind Atlas for South Africa
WT	-	Wind Turbine