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: _____ University number: ***20555318***

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

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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
		$irradiance = 1000\ Watt\ per\ square\ meter\ (kW.m^{-2})$
		$module\ temperature = 25\ degrees\ Celcius\ (℃)$
TSM	-	Technical Simulation Model
VI	-	Virtual Instrument
WASA	-	Wind Atlas for South Africa
WT	-	Wind Turbine