FAKULTEIT INGENIEURSWESE
FACULTY OF ENGINEERING

The design, analysis and installation of a photovoltaic solar power supply for a domestic swimming pool pump.

Project Proposal

Student: C Lewis

17006384

Supervisor: Prof TM Harms

Department of Mechanical and Mechatronic Engineering
University of Stellenbosch

February 2015

UNIVERSITEIT
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Executive Summary

Title of Project

Design, costing and financial performance analysis and possible installation and testing of a photovoltaic solar power supply for a domestic swimming pool pump installation.

Objectives

Investigating the shift in accessibility of solar energy for domestic use, targeting a high electricity device - a domestic swimming pool pump. Analysing the cost benefit, viability and performance of a photovoltaic solar power supply for a domestic swimming pool pump installation.

Which aspects of the project are new/unique?

Solar energy has found its place in the domestic appliance market in applications such solar water heating systems. A new aspect of the project is focusing a system, rather than a device in itself, using photovoltaic solar technology to power a domestic swimming pool pump. The focus is on designing a cost effective and efficient system that incorporates an existing AC swimming pool pump.

What are the expected findings?

The financial performance, feasibility and efficiency of a photovoltaic solar power supply outweighs the cost of installing and maintaining such a system. The advantages of the system could lead to nationwide solar energy solution accessibility, that will induce a larger solar energy uptake in domestic applications

What value will the results have?

The results will show the viability and advantages of making solar energy accessible to the domestic consumer, which could reduce electricity costs for the consumer and contribute to reducing the pressure on the national power grid.

If more than one student is involved, what part will I do?

N/A

Which aspects of the project will carry on after completion of my part?

The system will be maintained at the located installed site. The system will be modular which allows for additional solar panels. These additions will provide increased power production and permit increased load applying, which eventually could lead to an energy self-sufficient household.

Plagiarism declaration

I know that plagiarism is wrong.

Plagiarism is to use another's work (even if it is summarised, translated or rephrased) and pretend that it is one's own.

This assignment is my own work.

Each contribution to and quotation (e.g. "cut and paste") in this assignment from the work(s) of other people has been explicitly attributed, and has been cited and referenced. In addition to being explicitly attributed, all quotations are enclosed in inverted commas, and long quotations are additionally in indented paragraphs.

I have not allowed, and will not allow, anyone to use my work (in paper, graphics, electronic, verbal or any other format) with the intention of passing it off as his/her own work.

I know that a mark of zero may be awarded to assignments with plagiarism and also that no opportunity be given to submit an improved assignment.

I know that students involved in plagiarism will be reported to the Registrar and/or the Central Disciplinary Committee.

Name: ....

Student no: ....

Signature: ....

Date: ....

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1 Introduction

The commitment to renewable energy has been slow in South Africa despite the rising cost of electricity and the instability of the supply of electricity. With the resuming of power outages across the country in 2015, the consumer is left with the option to do without some electrical devices or finding another solution: renewable energy.

South Africa's climate conditions make swimming pools a desirable option, which attributes to the countries 672,000 domestic swimming pools. (General Household Survey, 2013: P0318) This means almost half of the population's households are running swimming pool pumps and since domestic swimming pools contribute to at least 11% of the average household's energy consumption, (Eskom Homeflex Tariffs, 2011) there is a need to decrease the power consumption of running these swimming pool pumps.

The climate conditions - and the decreasing cost of solar photovoltaic power - gives a solution to the consumer's electricity need, even for less critical devices such as swimming pool pumps. The solution of a solar photovoltaic power supply for domestic swimming pools will reduce the pressure on the country's electricity infrastructure and enable the consumer to care for his/her pool without increased costs.

2 Objectives

The project is targeted at the design, performance and financial viability of using a solar photovoltaic power supply for a domestic swimming pool pump installation. The objectives of the project is as follow:

2.1 Investigate the options to dissipate extra electricity generated in the system.

2.2 Develop a computer program to analyse the financial viability of multiple scenarios, taking into account electricity tariffs, lifetime and other factors that influence the installation of the system.

2.3 Design, install and test a solar photovoltaic power supply system in a real case scenario to determine the feasibility of the system.

2.4 Determine the available solar resource at the chosen setup location, the amount of panels and their orientation needed to achieve the specifications.

2.5 Recommend if, and which system will decrease the pressure on the electricity infrastructure while still being financially- and safety risk free, for consumers when investing in solar photovoltaic power as supply for domestic swimming pools.

3 Motivation

South Africa has great potential to commit to renewable energy, especially solar energy since it has good climate conditions for photovoltaic solar technology. Currently, the country needs alternative power solutions since the national power grid is under strain, leaving consumers with increasing electricity costs, or without any electricity. Making renewable (solar) energy accessible for domestic use could decrease electricity cost for the consumer and country, and reduce the pressure on the national power grid.

As mentioned previously, swimming pool pumps are high electricity consumers, which makes it a device ready to shift the accessibility of renewable (solar) energy to the domestic consumer. Currently no rebate is given by Eskom for dedicated photovoltaic solar power supplied swimming pool pumps but with the increase in application of this renewable energy solution, it could contribute to the reducing of pressure on the national power grid

4 Planned Activities

The cost and time associated with each activity is supplied in the Appendices. These guidelines will ensure that the project is completed within it's time and cost limitations:

2.1 Literature Study

Research literature regarding existing photovoltaic solar power supply systems for domestic use. Determine the different options regarding dissipating power not used by the swimming pool pump system. Research how the location and orientation of the solar panels influence the system and how to safeguard photovoltaic solar power supply system against system failure. Determine which regulations apply to the installing of photovoltaic solar power systems for domestic use.

2.2 Design

Design the photovoltaic solar system based on the research literature results. Design how the system is controlled, how it is safeguarded against system failure, how DC to AC conversion is solved and how all components will be connected in the system. Design a system that is efficient but also adheres to the specifications included in the project description. Design an efficient method to collect data for testing and analysis after the system is installed.

2.3 Financial Analysis

Determine a manner in which to take into account the cost of different system solutions, their advantages and system lifetime, to perform a valid financial analysis. Determine the current financial impact of a system which does not use solar energy but rather grid electricity. Determine if a photovoltaic solar power supply is financially more viable for the consumer. Determine the cost of the different components needed in the system.

2.4 Final design

Determine the final system solution which is subjective to the previous three planned activities. Determine what components and equipment is needed to install the designed system. Set a safety risk plan, to prevent injury, which states the presence of safety risks for using and installing the system. Since a photovoltaic solar power supply system is a high voltage application, a third party will be consulted to confirm that the design is functional and safe to use and install.

2.5 Buy Resources

Contact suppliers of photovoltaic solar products to purchase the chosen components needed to install the system. As seen in the Gantt chart, Figure 1, enough time is allocated for the acquisition of these components to ensure sufficient time for installing and testing the system. If possible, all components will be purchased locally as to support the local economy and to attain these components without delay.

2.6 System Setup

The designed system will be installed at the chosen location, 33°56’14’’S 18°53’22.8’’E. The system will be installed according to safety regulations since it is a high voltage application, and at an elevated height. Installation shall occur in short period of time as soon as all components are attained, to prevent safety risks such as unattached electrical connections. The components will be installed and maintained as prescribed by the manufacturer.

2.7 Testing

Testing procedures will be determined to efficiently collect data from the system. Data such as running hours, voltage supplied by the solar panels and amount of power dissipated will be collected over a time period longer than a month, as seen in Figure 1.

2.8 Data Analysis

Determine the efficiency of the system through the test data and compare to the data supplied by the manufacturer. Proved efficiency graphs and determine from the collected data if a photovoltaic solar power supply is a viable solution to power a 1kw 220V AC domestic swimming pool pump.

2.9 Report Writing

Document the procedures followed for research, design, installation and testing methods of the photovoltaic solar power supply system. Conclude if the photovoltaic solar power supply is a solution which adheres to the safety and financial risks involved in the application of powering a swimming pool pump. Conclude if the application of such systems could decrease the consumer's impact on the national power grid while still being advantageous to the consumer.

5 Conclusions

South Africa has a lasting electricity crisis which impacts the consumer's electricity usage through a lack of electricity and high fees. With the diminishing cost of solar photovoltaic power, alternative solutions become accessible to the domestic consumer. The proposed project encompasses the design, costing, financial performance analysis, installation and testing of a photovoltaic solar power supply for a domestic swimming pool pump system.

A shift in the accessibility of renewable (solar) energy to the domestic user will be provided by the project, if successful. With this access to renewable energy, more consumers nationwide would incorporate renewable energy in their households, not only for swimming pool pumps but other household devices as well. Having a renewable energy culture could ease the pressure on the country's power infrastructure and transform South Africa into a power sustainable country, without relying on harmful fossil fuels.

The project is expected to last 190 days, as seen in Figure 1, with a total expected cost of R144, 900. As mentioned previously, the design will be presented to a third party to confirm the validity since it is a high voltage application.

6 References

Eskom Homeflex Tariffs. 2011. [Online]. Available: http://www.eskom.co.za/ CustomerCare/ TariffsAndCharges/Documents/ Eskom%20Booklet.pdf. [2015, February 24].

General Household Survey. 2013. *Statistics South Africa.* Statistical Release P0318.

Appendix A Financial Analysis

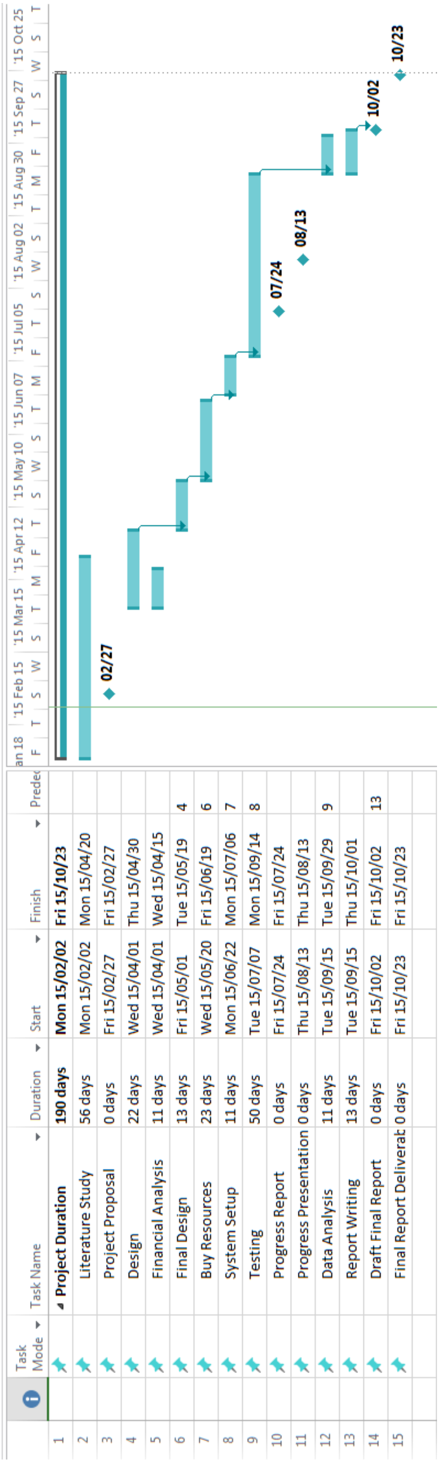
A.1 Cost per Activity

Table 1: Cost per Activity for a photovoltaic solar power supply for a domestic swimming pool pump installation.

Activity	Engineering Time		Operating Costs	Capital Costs	Facility Use	TOTAL
	hr	R	R		R	R
Literature Study	40	14, 000				14, 000
Design	30	10, 500				10, 500
Financial Analysis	20	7, 000				7, 000
Final design	15	5, 250				5, 250
Buy Resources	1	350		30, 000		30, 350
System Setup	20	7, 000	100		500	7, 600
Testing	100	35, 000				35, 000
Data Analysis	60	21, 000				21, 000
Report Writing	40	14, 000	200			14, 200
TOTAL	326	114, 100	300	30, 000	500	144, 900

Appendix B Scheduling

B.1 Gantt Chart



	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Project Duration	190 days	Mon 15/02/02	Fri 15/10/23	
2		Literature Study	56 days	Mon 15/02/02	Mon 15/04/20	
3		Project Proposal	0 days	Fri 15/02/27	Fri 15/02/27	
4		Design	22 days	Wed 15/04/01	Thu 15/04/30	
5		Financial Analysis	11 days	Wed 15/04/01	Wed 15/04/15	
6		Final Design	13 days	Fri 15/05/01	Tue 15/05/19	4
7		Buy Resources	23 days	Wed 15/05/20	Fri 15/06/19	6
8		System Setup	11 days	Mon 15/06/22	Mon 15/07/06	7
9		Testing	50 days	Tue 15/07/07	Mon 15/09/14	8
10		Progress Report	0 days	Fri 15/07/24	Fri 15/07/24	
11		Progress Presentation	0 days	Thu 15/08/13	Thu 15/08/13	
12		Data Analysis	11 days	Tue 15/09/15	Tue 15/09/29	9
13		Report Writing	13 days	Tue 15/09/15	Thu 15/10/01	
14		Draft Final Report	0 days	Fri 15/10/02	Fri 15/10/02	13
15		Final Report Deliverab	0 days	Fri 15/10/23	Fri 15/10/23	

Figure 1: Gantt Chart