Queensland University of Technology

Bachelor Of Engineering

BEB801: Undergraduate Thesis (Project 1)

Project Proposal and Progress

Feasibility of Low Voltage Direct Current Power Distribution

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Executive Summary

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1 Introduction

In most Australian buildings power is consumed directly from the grid. All appliances are connected to one switchboard but can be separated over various circuit breakers. Generally Australian appliances will use Direct Current (DC) electricity but the outlets provide an Alternating Current (AC) source of 240V at a frequency of 50Hz. Each device therefore requires an inverter that converts this signal into the required constant DC voltage and current specific to that device.

This project will consider the feasibility of converting a portion of power distribution from the standard 240V alternating current from the grid with an alternative solution. The considered option is utilising a low voltage direct current on a separate grid to power consistently low consumption devices such as lighting or electronics charging devices.

Alternative power generation systems will be considered as well as whether the new possibilities for generation and distribution methods could be used in applications larger than residential homes. The additional locations for this application that will be analysed are apartment, industrial and commercial complexes.

2 Background and Literature Review

2.1 Introductory Statement

Due to my personal experience working as a trainee electrical engineer for an electrical contractor I have a stronger understanding of power systems in the construction industry than most students at my level. This project topic has a fairly large scope and will require a broad understanding of the areas listen below.

- Power distributions systems
- Alternative electricity generation solutions
- Electrical safety mechanisms
- Australian standards
- Tariffs
- Direct current vs alternating current
- Converters and inverters

2.2 Literature Review

2.2.1 Current Power Distribution Systems

Power systems consist of four major sections; generation, transmission, distribution and loads. AC electricity is generated in power plants and sent through high voltage transmission lines to substations and distributed to switchboards for use in residential, commercial and industrial areas [1]. In order to transport electricity over large distances (excess of 2km) without severe losses, very high voltage and low current is used [1]. This is voltage is lowered and current increased by a transformer at the substation and again at the residence.

2.3 Alternative Electricity Generation Solutions

In order to increase efficiency of power systems through utilising a low voltage DC subsystem, alternatives to drawing standard AC electricity from the grid must be considered. In Australia, a strong option for the generation alternative is photo-voltaic systems that are also known as solar panels. These systems will convert the sun's rays into electricity

via a DC-DC converter and a DC-AC inverter and battery [2]. An important aspect is that the electricity is produced in DC and will require no inverter in a DC system.
Stuff on generators?

2.4 Electrical Safety Mechanisms

For electricity to each the home and be utilised for devices there must be safety mechanisms installed to ensure damage is not done to the user or devices. The protective devices requiring consideration throughout this project will be fuses, circuit breakers and switchboards [3]. These devices are placed through the circuit to protect the more expensive equipment closer to the transformer and grid. A fuse is a simple device that acts as a sacrificial lamb for the protection of the more expensive devices. An internal wire will melt when too much current flows through therefore interrupting the connection [3]. A circuit breaker is a smarter and re-useable version of a fuse that is triggered by overcurrent, overloads or shirt circuits to fulfil the same purpose [3]. The switchboard is a device that connects a home or building to the electrical grid and allows for individual circuits to be run for different purposes throughout the complex [3].

2.5 Australian Standards

Australian standards will be an integral part of this project. Without adhering to the rules and regulations put in place, the devised system will not be legally allowed to be installed. There are three standards that will be relevant to this report; AS3000, AS3008 and AS3015. The AS/NZS 3000 covers the standards realted to electrical installations or wiring rules within Australia and New Zealand [4]. These standards will be the main reference point however there are the additional publications of AS/NZS 3008 which are the regulations specifically related to electrical installations and cable specifications [5]. The final standards taken into consideration will be AS/NZS 3015 which specifically disctates the rules with regards to electrical installations of extra low voltage direct current power supplies and services earthing within public telecommunications [6].

2.6 Tariffs

Tariffs will be an important considerion with the feasibility of this project due to the possibilities of cost reduction. User expenses could theretically be reduced by implementing a system off the grid. Government policies have been put in place in order to prompt an increase in investment in renewable energy sources [7]. Users are able to

sell their unused generated electricity back to the grid to reduce their overall electricity bills or possibly profit if consumption is low enough. In Queensland, according to the SolarChoice website a feed-in tariff of $0.06/kWh can be earned [8]. By not connecting the photo voltatic panels to the grid, this tariff can not be received however there is the possibility that it is more efficient and will produce less energy loss by storing in local batteries and running simple circuits rather than feeding the grid [9]. The consideration will be whether the cost reduction in electricity bill will be worth the investment in the equipment and future cost reduction.

2.7 Direct Current & Alternating Current

3 Program and Design of the Proposed Research Investigation

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3.1 Objectives, Methodology and Research Plan

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4 Final Discussion & Conclusion

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References

[1] M. Amin, Y. Arafat, S. Lundberg, and S. Mangold, "Low voltage DC distribution system compared with 230 V AC," *2011 IEEE Electrical Power and Energy Conference, EPEC 2011*, pp. 340–345, 2011.

[2] L. Pillay and K. S. Karimov, "Photo-Voltaic System," in *3rd International Conference on Electrical & Computer Engineering*, no. December, (Dhaka, Bangladesh), pp. 28–30, ICECE, 2004.

[3] United States Department of the Interior, "Methods for Coordinating System Protective Equipment," *Facilities Instructions, Standards, and Techniques*, vol. 3-9, no. December 1991, 2000.

[4] Standards Australia, "AS/NZS 3000: Wiring Rules," pp. 1–21, 2007.

[5] Standards Australia, "AS/NZS 3008: Electrical Installations," pp. 1–136, 2010.

[6] Standards Australia, "AS/NZS 3015: Electrical Installations of Extra Low Voltage DC Power Supplies and Service Earthing Within Public Telecommunications Networks," pp. 1–61, 2004.

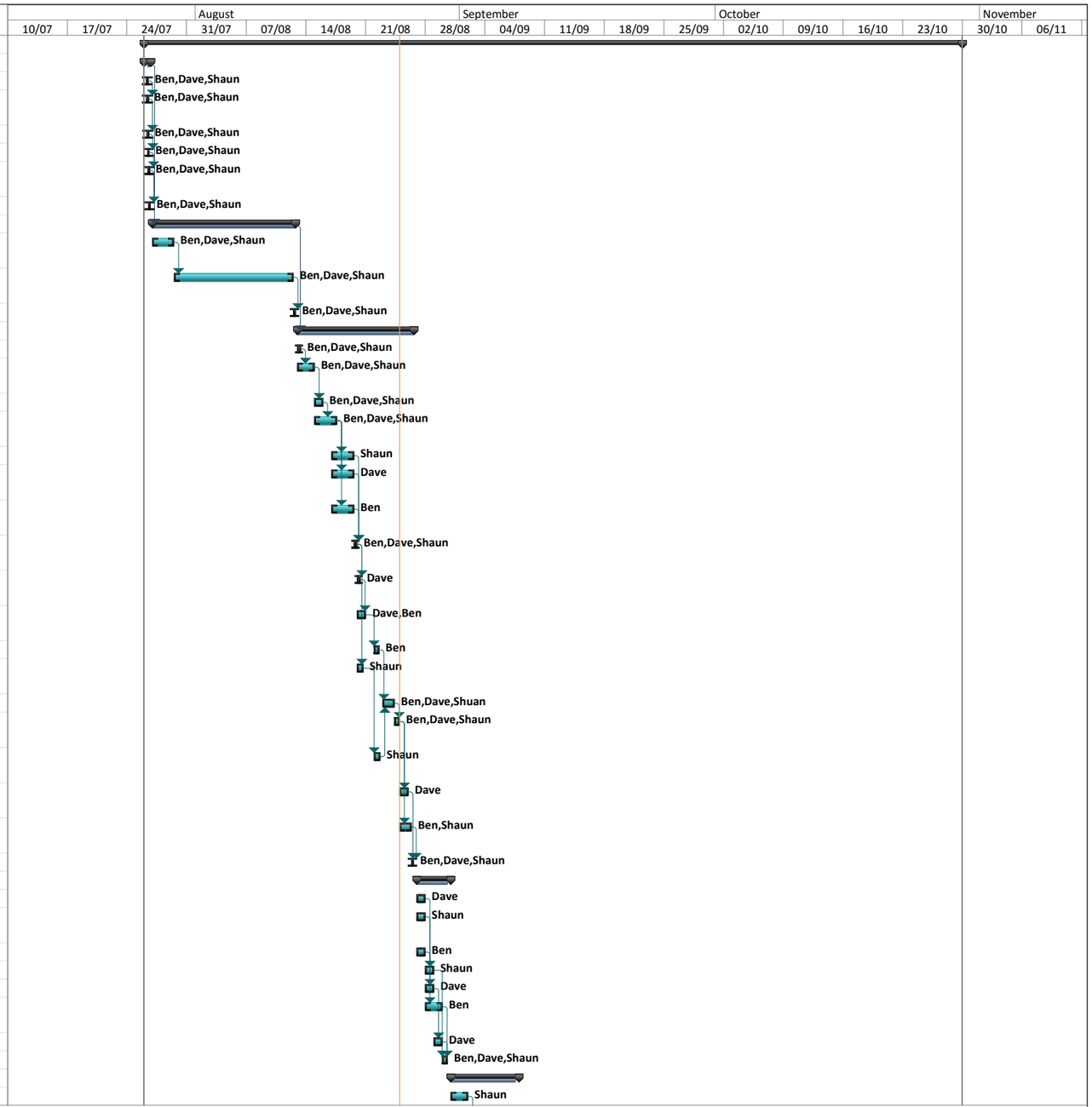
[7] T. Nelson, P. Simshauser, and S. Kelley, "Australian Residential Solar Feed-in-Tariffs: Industry Stimulus or Regressive Form of Taxation," *Economic Analysis and Policy*, vol. 41, no. 2, pp. 113–129, 2011.

[8] SolarChoice.net, "Which electricity retailer is giving the best solar feed in tariff?," 2016. http://www.solarchoice.net.au/blog/which-electricity-retailer-is-giving-the-best-solar-feed-in-tariff/?Qld.

[9] S. Antoniou, A, Tzimas, A, Rowland, "Transition from AC to DC Low-Voltage Distro Networks," *IET Generation, Transmission & Distribution*, vol. 9, no. 12, pp. 1391–1401, 2015.

Appendix 1: Project Gantt Chart - Page 1

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**ENB345 Design Task**	**229.5 days**	**Tue 26/07/16**	**Sat 29/10/16**		
2		**Introduction Phase**	**1.1 days**	**Tue 26/07/16**	**Tue 26/07/16**		
3		Read Brief	0.11 days	Tue 26/07/16	Tue 26/07/16		Ben,Dave,Shaun
4		Organise Group Resources/Communic	0.05 days	Tue 26/07/16	Tue 26/07/16	3	Ben,Dave,Shaun
5		Explore Themes	0.11 days	Tue 26/07/16	Tue 26/07/16	4	Ben,Dave,Shaun
6		Begin Logbook	0.21 days	Tue 26/07/16	Tue 26/07/16	5	Ben,Dave,Shaun
7		Organise Regular Meeting	0.05 days	Tue 26/07/16	Tue 26/07/16	6	Ben,Dave,Shaun
8		Brainstorm Ideas	0.22 days	Tue 26/07/16	Tue 26/07/16	7	Ben,Dave,Shaun
9		**Beginning Phase**	**39.5 days**	**Wed 27/07/16**	**Fri 12/08/16**	**2**	
10		Finalise Two Themes	5.2 days	Wed 27/07/16	Fri 29/07/16		Ben,Dave,Shaun
11		50 Logbook Ideas Working	33.5 days	Fri 29/07/16	Fri 12/08/16	10	Ben,Dave,Shaun
12		Submit Logbook	0.6 days	Fri 12/08/16	Fri 12/08/16	11	Ben,Dave,Shaun
13		**Proposal Phase**	**32 days**	**Sat 13/08/16**	**Fri 26/08/16**	**9**	
14		Finalise Theme	0.11 days	Sat 13/08/16	Sat 13/08/16		Ben,Dave,Shaun
15		Research Journals on Theme	3.9 days	Sat 13/08/16	Sun 14/08/16	14	Ben,Dave,Shaun
16		Patent Search	1.5 days	Mon 15/08/16	Mon 15/08/16	15	Ben,Dave,Shaun
17		5 Problem Solutions Each	5.5 days	Mon 15/08/16	Wed 17/08/16	16	Ben,Dave,Shaun
18		RFID Research	5.5 days	Wed 17/08/16	Fri 19/08/16	17	Shaun
19		User Group Research	5.5 days	Wed 17/08/16	Fri 19/08/16	17	Dave
20		LaTeX Document Preparation	5.5 days	Wed 17/08/16	Fri 19/08/16	17	Ben
21		Assign Proposal Sections	0.8 days	Fri 19/08/16	Fri 19/08/16	18,19,20	Ben,Dave,Shaun
22		Section: Problem Definition	0.11 days	Sat 20/08/16	Sat 20/08/16	21	Dave
23		Section: Design Requirements	1.5 days	Sat 20/08/16	Sat 20/08/16	22	Dave,Ben
24		Section: Rationale	0.6 days	Mon 22/08/16	Mon 22/08/16	23	Ben
25		Section: User Population	0.9 days	Sat 20/08/16	Sat 20/08/16	21	Shaun
26		Section: Solutions	2.5 days	Tue 23/08/16	Wed 24/08/16	24,28	Ben,Dave,Shuan
27		Section: Design Use Scenario	1.5 days	Wed 24/08/16	Thu 25/08/16	26	Ben,Dave,Shaun
28		Section: Patent Search	0.9 days	Mon 22/08/16	Mon 22/08/16	25	Shaun
29		Section: Gantt Chart	1.5 days	Thu 25/08/16	Thu 25/08/16	27	Dave
30		Final Report Editing	2.5 days	Thu 25/08/16	Fri 26/08/16	27	Ben,Shaun
31		Submit Report	0.6 days	Fri 26/08/16	Fri 26/08/16	30,29	Ben,Dave,Shaun
32		**Project Pitch Phase**	**8.7 days**	**Sat 27/08/16**	**Tue 30/08/16**		
33		Introduction	2 days	Sat 27/08/16	Sun 28/08/16		Dave
34		Patent/Literature/Pri Art	2 days	Sat 27/08/16	Sun 28/08/16		Shaun
35		Idea Exploration	2 days	Sat 27/08/16	Sun 28/08/16		Ben
36		User Group	2 days	Sun 28/08/16	Mon 29/08/16	34	Shaun
37		Scenario	2 days	Sun 28/08/16	Mon 29/08/16	33	Dave
38		Scope of the Project	3.9 days	Sun 28/08/16	Mon 29/08/16	35	Ben
39		Milstones	1.5 days	Mon 29/08/16	Mon 29/08/16	37	Dave
40		Present	0.6 days	Tue 30/08/16	Tue 30/08/16	39,38,36	Ben,Dave,Shaun
41		**Design Phase**	**18.3 days**	**Wed 31/08/16**	**Wed 07/09/16**		
42		RFID Research	3.9 days	Wed 31/08/16	Thu 01/09/16		Shaun



Project: ENB345_Group21_Timeli
Date: Thu 25/08/16

Task | Summary | External Milestone | Inactive Summary | Manual Summary Rollup | Finish-only
Split | Project Summary | Inactive Task | Manual Task | Manual Summary | Deadline
Milestone | External Tasks | Inactive Milestone | Duration-only | Start-only | Progress

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