Mobile Phone Charging Station

By Nathan Sharpe

30648978

A report submitted to the School of Engineering and Energy, Murdoch University in partial fulfilment of the requirements for the degree of Bachelor of Engineering.

2010

ENG460: Engineering Thesis
ENG460 Engineering Thesis

Academic Supervisor endorsement pro forma

This is to be signed by your academic supervisor and attached to each report submitted for the thesis.

I am satisfied with the progress of this thesis project and that the attached report is an accurate reflection of the work undertaken.

Signed:

Date:
Declaration

I declare that this thesis is my own work, it contains no material previously published or written by any other person, except where due reference is given in text.
Acknowledgments

Special thanks to my supervisors, Dr Martina Calais and Simon Glenister.
Abstract

This thesis project set out to design a mobile phone charging station that is Photovoltaic (PV) powered. It was to be designed so that it could be used at outdoor festivals and events such as the Southbound Music Festival. For this reason the charging station had to be portable and as it would be used at night there had to be an appropriate lighting set up. The design of the charging station had to be eye catching and could be based on a similar device called the LG Skycharger.

As this project was being designed for Murdoch Events to be used by Sunset Events, communication with the client was critical. An original design was created and then proposed to the client during a presentation, to determine if the design was appropriate. Once discussed it was decided that a few requirements needed to be modified. This original design was then customized to meet the new requirements and a second larger station design was also produced.

This resulted in two final designs, which meant that the client has two options and can select the design which is most suitable and meets their budget. The two stations that were designed were a 48 locker design and a 96 locker design. As it was assumed the stations would have access to the main power both have been configured so that if the battery bank is running low it can be charged using mains power. This makes it more versatile so that it has the ability to be used during winter, or for a number of continuous days.

The 48 locker charging station contains a PV system that has a rating of 875 W and a battery bank rated at 240 Ah. This battery bank has enough capacity to power the system for 17.4 hours assuming there is no solar power. It has been designed so that the PV system can be mounted on the back of a trailer to increase portability. The charging station is eye catching and will be constructed out of aluminium so that it is durable. For there to be appropriate lighting at night time LED lighting has been selected; this includes multi colour LED lights for decorative purposes, as well as white LED flood light which will provide a substantial amount of light surrounding the charging station. The total estimated price to construct the 48 locker version is $30,500.
The larger 96 locker charging station contains a Photovoltaic system that is twice as large as the 48 Locker Charging station, which results in a PV system rated at 1750 Watts and a battery bank of 480 Ah. This battery bank has enough capacity to power the system for 17.7 hours assuming there is no solar power. The PV system will also be mounted on the back of a trailer. The charging station is a similar design to the 48 locker version but to house the increased amount of lockers it is slightly larger. It is also constructed out of aluminium. This station contains the same lighting set up as the 48 locker version. The total estimated price to construct this 96 locker version is $43,500.

All of the main aspects of the project have been completed however there are some sections that could be looked into in more detail. These include, finding an appropriate all in one charger, finding a way to connect the AC loads and also selection of an appropriate system configuration. This leaves further study for the project. Both of the designs meet the budget, for this reason the larger 96 locker charging station would be the recommended option because it can charge twice as many phones.
# Table of Contents

*Introduction* ......................................................................................................................................................... 1

*Timeline of the project* .............................................................................................................................................. 2

1. Research ................................................................................................................................................................. 4
   1.1 Other types of mobile phone charging stations ......................................................................................... 4
       1.1.1 LG Skycharger ........................................................................................................................................ 4
       1.1.2 Chargebox ............................................................................................................................................. 6
   1.2 Mobile Connections .......................................................................................................................................... 8
       1.2.1 All in one Chargers ............................................................................................................................... 8
       1.2.2 General Power Outlet ......................................................................................................................... 9
       1.2.3 Power Rating of Different Mobile Phone Chargers ......................................................................... 10
       1.2.4 The inactive mobile phone charger power consumption issue ....................................................... 10
   1.3 Types of Lockers Available ............................................................................................................................ 12
       1.3.1 Davell Lockers ........................................................................................................................................ 12
       1.3.2 Excel Lockers ......................................................................................................................................... 13
   1.4 Choosing the Marquee .................................................................................................................................... 14
       1.4.1 The Pavilion Range .............................................................................................................................. 15
       1.4.2 The Crest Range ..................................................................................................................................... 15
       1.4.3 Extreme Marquee print design ............................................................................................................... 15
       1.4.4 Umbrella Alternative ........................................................................................................................... 16
   1.5 Mounting the solar panels on a trailer ............................................................................................................. 16
   1.6 Charging Station Material ............................................................................................................................... 18
       1.6.1 The Selected Material .......................................................................................................................... 19
       1.6.2 Metal Work Companies ....................................................................................................................... 19
   1.7 Lighting ............................................................................................................................................................... 20

2. Sizing the System ...................................................................................................................................................... 22
   2.1 System Sizing Specification .............................................................................................................................. 22
   2.2 Three Sizing Scenarios .................................................................................................................................... 25
       2.2.1 - Original System ..................................................................................................................................... 25
       2.2.2 - New 48 Locker System ..................................................................................................................... 27
       2.2.3 - 96 Locker system ............................................................................................................................... 29
2.3 System Protection ........................................................................................................... 32
  2.3.1 Main Battery Protection ......................................................................................... 32
  2.3.2 Lightning Protection ............................................................................................... 32

3. Design ........................................................................................................................... 33
  3.1 Original Charging Station Design ............................................................................. 34
    3.1.1 Design of the charging station ........................................................................... 34
      Design 1 .................................................................................................................. 35
      Design 2 .................................................................................................................. 37
      Design 3 .................................................................................................................. 38
      Design 4 .................................................................................................................. 39
      Design 5 .................................................................................................................. 40
    3.1.2 Charging station and locker dimensions ............................................................. 41
    3.1.3 Selected Design .................................................................................................. 43
    3.1.4 Design of the Marquee and Mounting Frame .................................................... 49
      3.1.4.1 Solar Panel Positioning ................................................................................ 49
      3.1.4.2 PV Mounting Frame .................................................................................... 50
  3.2 Modified Charging Station Design ........................................................................... 52
    3.2.1 Design of the 96 Locker Charging Station .......................................................... 52
    3.2.2 The Connection Method ..................................................................................... 58
    3.2.3 The Umbrella Design ......................................................................................... 59
    3.2.4 The PV system Mounted on a Trailer .................................................................. 59
      3.2.4.1 - 48 Locker System Mounting .................................................................... 59
      3.2.4.2 - 96 Locker system Mounting ..................................................................... 60
    3.2.5 Lighting ............................................................................................................... 62

4. Sourcing and Pricing ..................................................................................................... 64
  4.1 The PV system parts ................................................................................................. 65
    4.1.1 - 48 Locker Station ............................................................................................ 65
    4.1.2 - 96 Locker Station ............................................................................................ 66
  4.2 The Charging Station parts ....................................................................................... 67
    4.2.1 - 48 Locker Station ............................................................................................ 67
    4.2.2 - 96 Locker Stations .......................................................................................... 67
  4.3 Miscellaneous items ................................................................................................. 68
# List of Figures

<table>
<thead>
<tr>
<th>Figure Reference</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Project timeline</td>
<td>2</td>
</tr>
<tr>
<td>Figure 2.1</td>
<td>- Series system</td>
<td>24</td>
</tr>
<tr>
<td>Figure 2.2</td>
<td>- 48 Locker PV System</td>
<td>27</td>
</tr>
<tr>
<td>Figure 2.3</td>
<td>- 96 Locker PV System</td>
<td>30</td>
</tr>
<tr>
<td>Figure 3.1</td>
<td>- Design 1 views</td>
<td>35</td>
</tr>
<tr>
<td>Figure 3.2</td>
<td>- Design 1 3D view</td>
<td>35</td>
</tr>
<tr>
<td>Figure 3.3</td>
<td>- Design 2 3D view</td>
<td>37</td>
</tr>
<tr>
<td>Figure 3.4</td>
<td>- Design 2 views</td>
<td>37</td>
</tr>
<tr>
<td>Figure 3.5</td>
<td>- Design 3 views</td>
<td>38</td>
</tr>
<tr>
<td>Figure 3.6</td>
<td>- Design 3 3D view</td>
<td>38</td>
</tr>
<tr>
<td>Figure 3.7</td>
<td>- Design 4 3D view</td>
<td>39</td>
</tr>
<tr>
<td>Figure 3.8</td>
<td>- Design 4 views</td>
<td>39</td>
</tr>
<tr>
<td>Figure 3.9</td>
<td>- Design 5 views</td>
<td>40</td>
</tr>
<tr>
<td>Figure 3.10</td>
<td>- Design 5 3D view</td>
<td>40</td>
</tr>
<tr>
<td>Figure 3.11</td>
<td>- Locker height range compared to average Australians height.</td>
<td>42</td>
</tr>
<tr>
<td>Figure 3.12</td>
<td>- Proposed Charging Station base</td>
<td>42</td>
</tr>
<tr>
<td>Figure 3.13</td>
<td>- Proposed Charging Station base lid</td>
<td>44</td>
</tr>
<tr>
<td>Figure 3.14</td>
<td>- Proposed Charging Station locker housing</td>
<td>45</td>
</tr>
<tr>
<td>Figure 3.15</td>
<td>- Proposed Charging Station locker housing</td>
<td>46</td>
</tr>
<tr>
<td>Figure 3.16</td>
<td>- Proposed Charging Station roof</td>
<td>47</td>
</tr>
<tr>
<td>Figure 3.17</td>
<td>- Proposed Charging Station complete design</td>
<td>48</td>
</tr>
<tr>
<td>Figure 3.18</td>
<td>- The Pavilion Marquee</td>
<td>49</td>
</tr>
<tr>
<td>Figure 3.19</td>
<td>- The Crest Marquee</td>
<td>49</td>
</tr>
<tr>
<td>Figure 3.20</td>
<td>- PV system mounting frame options</td>
<td>50</td>
</tr>
<tr>
<td>Figure 3.21</td>
<td>- 96 Locker Charging Station base</td>
<td>53</td>
</tr>
<tr>
<td>Figure 3.22</td>
<td>- 96 Locker Charging Station Locker housing</td>
<td>54</td>
</tr>
<tr>
<td>Figure 3.23</td>
<td>- 96 Locker Charging Station locker housing</td>
<td>55</td>
</tr>
<tr>
<td>Figure 3.24</td>
<td>- 96 Locker Charging Station roof</td>
<td>56</td>
</tr>
<tr>
<td>Figure 3.25</td>
<td>- 96 Locker Charging Station complete design</td>
<td>57</td>
</tr>
<tr>
<td>Figure 3.26</td>
<td>- Description of connecting method</td>
<td>58</td>
</tr>
<tr>
<td>Figure 3.27</td>
<td>- 48 Locker System (left) and 96 Locker System (right) with umbrella</td>
<td>59</td>
</tr>
<tr>
<td>Figure 3.28</td>
<td>- 48 Locker PV system mounted on the trailer</td>
<td>60</td>
</tr>
<tr>
<td>Figure 3.29</td>
<td>- 96 Locker PV system mounted on the trailer</td>
<td>61</td>
</tr>
</tbody>
</table>
Figure 3.3 - Multi colour LED Lighting positioning .............................................................. 62
Figure 3.31 - White LED flood light position ................................................................. 63
Figure 5.1 - Minutes vs Percentage Charged Graph ............................................................ 71
Figure 2 - 48 Locker Charging Station ............................................................................ 74
Figure 3 - 96 Locker Charging Station ........................................................................... 75
Figure 4 - Switched system [20] .................................................................................... 77
Figure A.1 ....................................................................................................................... 102
Figure A.2 ....................................................................................................................... 103

List of Tables

Table 1.1 - Charger output voltages ................................................................................. 10
Table 1.2 - Print Design Prices ....................................................................................... 16
Table 2.1 - Proposed Battery sizes ................................................................................ 25
Table 2.2 - Original System sizing .................................................................................. 26
Table 2.3 - 48 Locker sizing ........................................................................................... 27
Table 2.4 - 96 Locker sizing ........................................................................................... 29
Table 3.1 - Design 1 pros and cons ................................................................................ 36
Table 3.2 - Design 2 pros and cons ................................................................................ 37
Table 3.3 - Design 3 pros and cons ................................................................................ 38
Table 3.4 - Design 4 pros and cons ................................................................................ 39
Table 3.5 - Design 5 pros and cons ................................................................................ 41
Table 4.1 - 48 Locker system parts pricing ..................................................................... 65
Table 4.2 - 96 Locker system parts pricing ..................................................................... 65
Table 4.3 - 48 Locker charging station pricing ............................................................... 67
Table 4.4 - 96 Locker charging station pricing ............................................................... 67
Table 4.5 - 96 Locker miscellaneous items pricing ......................................................... 68
Table 4.6 - Systems Final pricing .................................................................................... 69
Table 5.1 - Test 1 ............................................................................................................. 70
Table 5.2 - Test 2 ............................................................................................................. 71
Table 5.3 - Test 3 ............................................................................................................. 72