Solar Generation for Remote Boreholes

Team 12: Team Power

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**Table of Abbreviations and Acronyms**

|  |  |  |  |
| --- | --- | --- | --- |
| SGRB | Solar Generation for Remote Boreholes | BHP | Broken Hill Proprietary Company Limited |
| RA | Requirements Analysis | SWOT | Strengths, weaknesses, opportunities and threats |
| DA | Design Approach | IoT | Internet of Things |
| Jacobs | Jacobs Engineering Group Inc. |  |  |
| PM | Project Management |  |  |
| GHG | Greenhouse Gasses |  |  |
| LFG | Landfill Gas |  |  |

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Solar Generation for Remote Boreholes: Individual Design Approach

# Introduction

Team Power has been tasked by Jacobs Engineering Group Inc. (Jacobs) to design the power supply for a remote bore field attached to a mine site situated in the area around Newman, in the Pilbara region of Western Australia. These bores will provide process water for a nearby mine site. Team Power’s ultimate objective is to provide a design solution for Jacobs which optimizes delivery (by priority) of their stated and unstated requirements[1]. Jacobs have titled this task “Solar Generation for Remote Boreholes” (SGRB)[2].

## Purpose

This document effectively provides a snapshot of a critical planning stage in the project. It will be useful as a management tool, as well as for composing the final ‘lessons learned’ report upon project completion. This document presents a summary of all progress made by the author so far as a member of Group 12 (“Team Power”). This includes summaries of their review of current literature for requirements analysis (RA) and design approach (DA), contribution to RA and DA, project workflow, scope of involvement in crafting DA and the project management strategies they have implemented to improve project efficiency and quality.

## Scope

This document provides a summary of the authors contributions to date, including research, project management (PM) initiatives and the authors understanding of project workflow.

### Research to date

The author (Mark Mazzoni) was tasked with the initial research into the existing Newman power infrastructure; furthermore, the author was subsequently tasked with researching the legislative and legal limitations likely to be placed on the project. During RA, the author was tasked with investigating the requirement for the power generation infrastructure to last 10 years, for minimal environmental harm and for minimal construction time. For DA the author was additionally tasked with researching telemetry systems, as well as methods of costing and valuing design solutions proposed by other team members. The author was also tasked with researching the viability of energy generation using biofuels, landfill gas or nuclear, as well as further research into the existing grid. Each of these is discussed in section 3 of this document.

### Project Management

The author has played a key role in managing both Team Power and their progress on the project. This has included chairing and taking minutes at triweekly team meetings, creating scheduling documents, creating quality assurance documents, booking meeting venues,

Each of these initiatives is discussed in section 4 of this document.

### Project Workflow

A discussion of project workflow and design inputs, processes and outputs is included in section 5 of this document

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# Requirements

Despite a lukewarm reception (graded: 26/50), due to limited and vague feedback provided (as of 04/04/17), the project requirements have not changed substantially from those submitted with RA on the 24/03/17 [1]. For the sake of the brevity of this document the requirements summary list and description, taken from RA, is included in Appendix A. Additionally, each section of this report has been linked to a requirement using the priority rankings as reference numbers. For a full description of each requirement please see RA[1].

# Literature Review

## Requirements Analysis

In preparation for RA the author undertook a review of the literature describing the current state of overhead power generation and transmission in and around Newman, as well as a review of regulatory and legislative restrictions likely to apply to the project. Furthermore, in collaboration with all of Team Power, the author reviewed the relevant literature related to determining and assigning priority to client and Project Partner requirements. Summaries of this literature are included in the RA[1], but for the sake of brevity are not revisited here.

## Design Approach

Summaries of the literature reviewed by the author in preparation for the design phase of the project are given here, both for the purpose of facilitating design review and also to demonstrate the authors contribution to the project so far. Requirements addressed by each point are indicated with -#- using the numbering system from Appendix A. The brief summaries here by no means reflect the full volume of the author’s research.

### Management Structures

Project management is a living body of knowledge[3], so an up-to-date literature review on PM techniques and structures is essential when starting a project outside of an established work structure, both as a professional development tool and as a refresher. This was especially important for Team Power as it is comprised of students from various backgrounds and with varying skillsets.

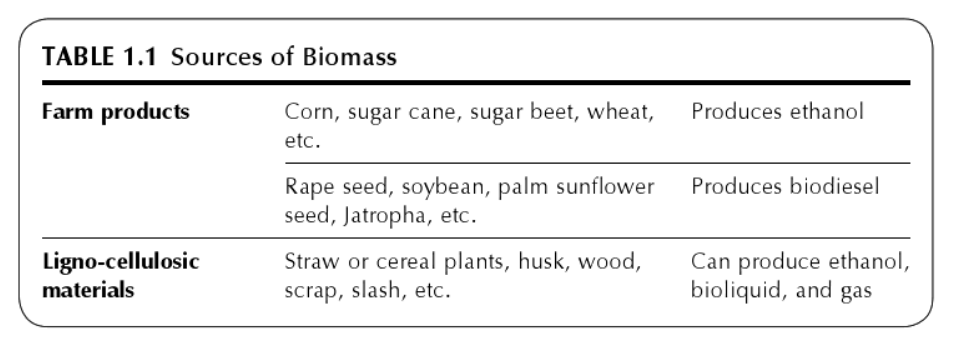
#### Team Management and Leadership (-4-,-5-,-10-)

Some of the project skills, tools and concepts highlighted by the literature review and subsequently used for team management and leadership were SWOT analysis[4], group formation and performance[5], collaborative structures[6] and intercultural interaction[7]. Further reevaluation of existing knowledge and skills in scheduling, reporting and documentation and record storage was performed in order to establish an optimal management system for Team Power.

### Power Generation Solutions

#### Biomass (-2-,-5-,-9-)

Creating energy from biomass, either directly or via conversion to biofuels, has been a staple for thousands of years[8]. New technologies leading to exploitation of new sources of biomass and increased efficiency of energy extraction from existing sources continue to make biomass one of the primary global energy sources[9-11]. Recent advances have allowed the use of biomass processing to create hydrogen for fuel cells[12-15].

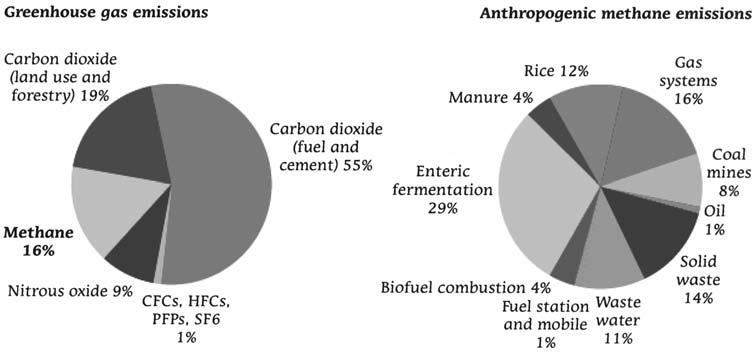
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*Figure 1: Table of biomass sources used to produce primary and secondary biofuels*[16]*.*

The usefulness of a source of biomass for energy revolves around its carbon cycle[11]. Key parameters include the speed at which carbon from the atmosphere be locked into a useable source, the energy density of this source and ease of recapturing carbon emissions created[17].

#### Landfill Gas (-2-,-5-,-9-)

The majority of generated solid waste ends up in landfill[18], largely because landfill provides a one-fits-all solution and therefore is often the cheapest waste disposal method in the short term[19]. Landfills can pollute local environments, including the air, land and water, by emitting greenhouse gasses (GHG) and by contaminating soil and groundwater[18]. Energy production from landfill gas nullifies one of these sources by processing landfill gas (LFG) and extracting useful components for combustion or chemical reaction[17, 20]. One major constituent is methane, which can make up between 40-60% of LFG. Methane’s high potency (as a GHG) and short atmospheric lifetime means that addressing methane emissions is a particularly effective approach for mitigating the near-term impacts of climate change[21].



*Figure 2: The proportion of GHG emissions made up by methane, and the proportion of anthropogenic methane produced by waste decomposition, as an indicator of the usefulness of landfill gas capture[21].*

#### Nuclear (-2-,-5-,-9-)

The use of nuclear power, as well as being unsuitable for the (small) scale of project power demand, was seen as immediately unfeasible due to Australian legislative and regulatory constraints[22]. For these reasons, and for the sake of brevity, this research is not summarized in this report.

#### Overhead Power (-2-,-3-,-5-,-10-)

Using overhead power transmission to supply the bore field (the ‘base case’) is ostensibly a viable option. The author has been instructed by Jacobs to assume that there are 22kV lines available from the mine site 10km away[23], which itself will derive power from a client-owned natural-gas-fired power plant in the Newman area[24, 25]. The supplied cost of power from the client’s power plant is 30c/kWh. The project partner’s assumption is that running overhead lines will be the most expensive and time consuming option[26], however Team Power will perform a thorough analysis before coming to any conclusions.

### Telemetry

Due to the remote nature of the bore field, and the critical role that maintaining adequate process water plays in mine operation[27], it is important to continuously monitor the performance of the power supply and pump system[28]. It is proposed that the telemetry system consume no more than 100W of 24V DC power[25]. Sensing and data logging equipment for the power system, as well as security, safety and site infrastructure, must be able to communicate with the remote operations center located at the client’s mine site. The project does not require design of a sensing system for the pumps themselves, but communication channels and bandwidth will need to be reserved for pump telemetry. Once specific iterations of design option technologies have been identified, application of internet of things (IoT) paradigms and technologies will allow for an efficient and effective telemetry system[28-30].

### Costing

#### Methodologies

Early indications from Team Power’s extensive literature review are that a hybrid solution is most likely to satisfy the project requirements. As more research is performed, detailed costings can be developed based on the exact iterations of technologies to be used; with resources such as Rawlinsons Construction Cost Guide and HOMER simulation software providing the basis for these[31, 32].

#### Further Research and Future Tasks

Jacobs’ representative has promised to deliver detailed pricing information for diesel generators (per kW produced) and local pricing of diesel (per unit volume), as well as pricing per km for overhead lines (including poles, wires etc.). Once these quotes are delivered comparison of price points for finalizing design options can begin.

# Project Management and Leadership

Successful completion of any project requires a synthesis of in-depth planning, good design, proper execution and rigorous finalization. Project management techniques provide the tools with which to achieve this[3].

## Summary of Project Management Objectives

The author’s objectives when acting within Team Power are to exhibit enthusiasm, demonstrate a willingness to communicate and compromise and to display leadership. This will hopefully lead to increased productivity from all team members and increased performance from Team Power.

## Initiatives Implemented

The author has already implemented multiple PM initiatives to contribute to and promote the success of the team. These include prescribed activities such as chairing team meetings, creating agendas and taking minutes for meetings for an equal share of time, as well as attending meetings with the principle partner. Furthermore, the author has independently developed multiple project management initiatives to aid the team. These include proposing, formatting and contributing to a “lessons learned” report immediately following the submission of RA and developing a loose team schedule (via Microsoft Excel, with the ultimate goal of creating a detailed Gantt chart in MS Project once final report deliverables are made clear). Further supportive activities undertaken on the author’s own initiative include creating online polls to arrange group meetings, booking meeting venues ahead of time, maintaining online repositories for group data such as Google Drive and GitHub and formatting and contributing to the team work-hours log sheet. Lastly, the author attempts to imbue a sense of fun and excitement into the project team, bringing positive attitudes and energy, thereby avoiding arguments and solving group dissent creatively.

## Outcome of Initiatives

Outcomes include improved team time management, tracking of work hours, ability of all members to be present at group meetings, on-time submission of group RA report and the generally positive attitude and culture of Team Power. The ongoing lessons learned investigation is expected to culminate in policy discussion prior to the submission of the group DA report; this is a direct outcome of the author’s actions.

## Future Initiatives

Further development of the team schedule into a detailed Gantt chart, formation of management policies from “lessons learned” documentation and implementation of these policies are expected to fall within the authors purview.

# Project Approach

See Appendix B for project data flow and approach

# Conclusion

In summary, the author has made it their priority to be a valuable and vibrant member of Team Power. The author’s portion of research and design analysis presented here forms but one part of a larger body of work produced by Team Power for the Group Design Approach. The design knowledge and management strategies briefly summarized here should help to ensure the success of the SGRB project.Appendices

## Appendix A: Project Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Priority | Requirement Shorthand | Requirement Description | Classification |
| 1 | 24/7 | The power generation system is required to operate for 24 hours a day, 7 days a week, 365 days a year. | EXP, SPO |
| 2 | 90kW++ | The power generation system must produce 90kW of power to supply the main pumps, plus additional power to supply other essential systems. | EXP, SPO |
| 3 | Newman | The power generation system must operate in Newman. This includes tolerating the harsh conditions. | EXP, SPO |
| 4 | Safety | The system must run safely. Any safety equipment that requires power must also be supplied. | EXP, SPO, UNS |
| 5 | Economy | Maximize the economy of the proposed solution. | EXP, SPO |
| 6 | Telemetry | The system requires telemetry and communications equipment, and these will also require power. | EXP, SPO |
| 7 | Maintainable | The system must be maintainable. | EXP, UNS |
| 8 | 10-year life | The system must last for at least ten years | EXP, SPO |
| 9 | Environment | The proposed solution should minimize harm to the environment. | EXP, EXC |
| 10 | Time | The proposed solution should take a minimum amount of time to construct. | EXP, EXC |

*Figure A: Summary of Project Requirements including classifications. EXP - Expecters, SPO - Spokens, UNS - Unspokens, EXC - Exciters*

## Appendix B: Project Approach



*Figure B: Flow chart for project inputs*