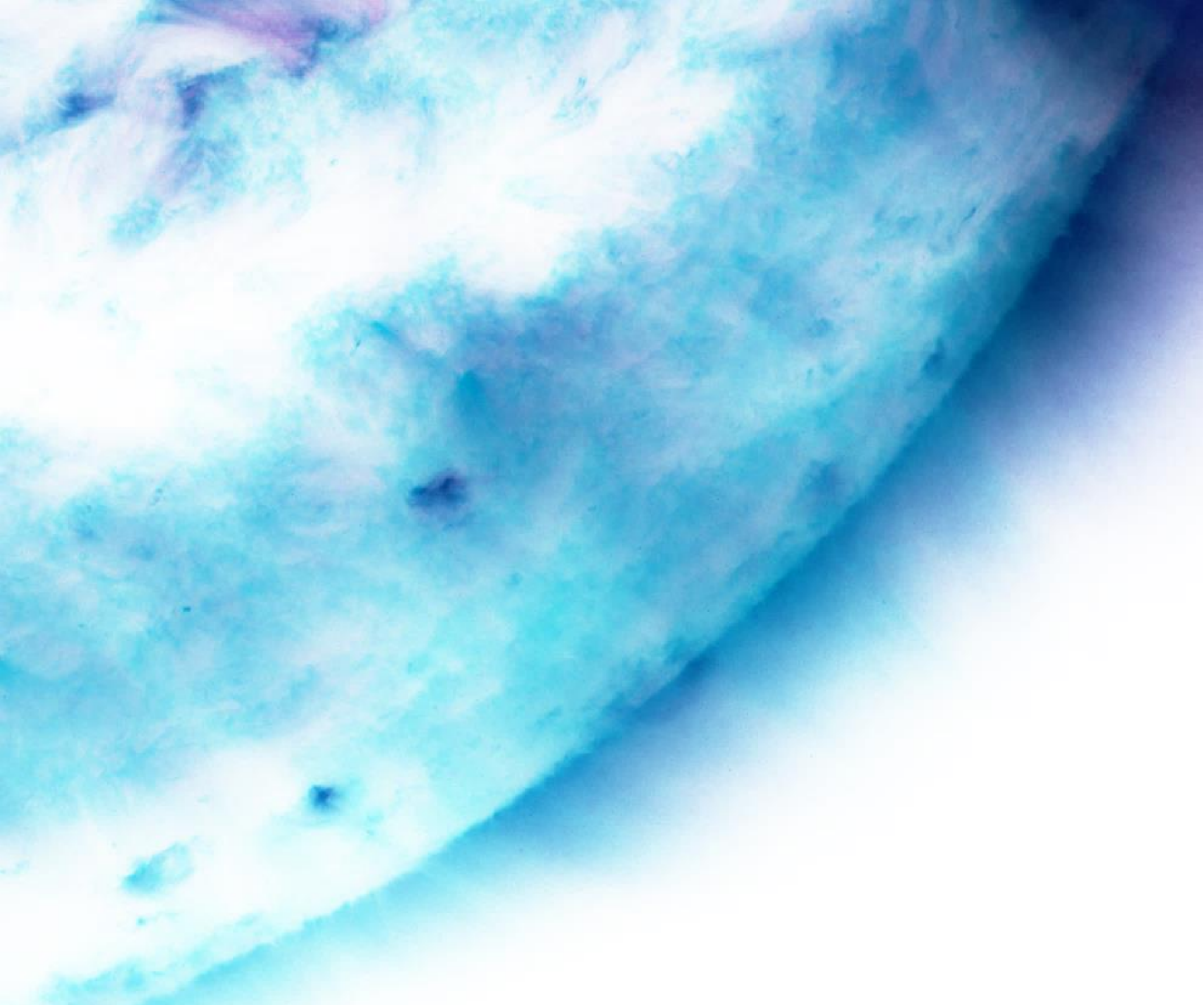

Discover Your Potential:

A Solar Energy Estimation Project

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Project Plan

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11 Pages

Problem Statement – Summary

The world is in a state of flux; climate changes are becoming more drastic by the year, and the culprit is increasingly clear: our non-sustainable energy sources. This has caused a shift recently – where nations and organizations around the world are making the switch to renewable energies to slow the rate of climate change. It is critical for our continued survival as a species to power our world without destroying it, and there is an energy source that can power our civilization for millions of years, sustainably: solar energy.

Photovoltaic (PV) energy, the most direct way to capture the sun's energy, is also experiencing a steep drop in costs (NREL, 2014). A few countries are already taking advantage of this, and have made great leaps and strides toward a renewable future. China, Germany, Japan, the United States and Italy are leading, with the most cumulative installed capacity for solar energy. Canada's cumulative installed capacity doesn't compare to the previous countries; yet, in 2015, installed a total of 0.6 Gigawatts of capacity from solar electricity, the tenth-most worldwide that year (IAE, 2015).

Canada already powers most of the country with renewable energy – almost 60% from hydro-electricity – yet far more can be done. Many communities still rely on fossil fuel combustion for energy, like those in Alberta and Saskatchewan (Statistics Canada, 2015). To help spur change toward renewable energies, they must be seen as not just the sustainable solution, but also the economic one.

This project aims to use geospatial technologies (GIS) to show where photovoltaic electricity can be produced for less than non-renewable sources – hopefully spurring sustainable changes in Canadian communities.

Contents

1 – Project Technical Approach

Producing estimates for the cost of electricity is an approachable way to help Canadians compare solar energy to their current power source. Yet, to produce accurate costs of electricity, the total installed and maintained cost of a solar energy system must be estimated. Thankfully, the United States has done thorough research on the topic at the National Renewable Energy Laboratory (NREL), and have made most of their reports available online. These provide the basis for the solar irradiance calculations and system estimates in this project.

Next, there are many ways to apply GIS to provide information – free information to the public is helpful to help change the overall acceptance of new technologies, yet won't cause changes on its own. The information produced must, then, both be accessible to the public, and be useable by decision makers. This is due to the upfront costs incurred with solar energy systems; they provide decades of value, but are still prohibitively expensive for most homes – which will make the information produced by this project far more valuable to municipalities and energy producers.

So the project targets two main values: accessibility and ease of use. The information produced should be accessible to the public, for those who want to know more, and should be useable by non-GIS/-energy professionals.

The project will focus on rooftop PV and rural utility-scale PV systems, due to their greater potential impact on economical energy generation. Rooftop PV systems have the greatest potential in higher density areas with ample solar resources – in Canada, only a few locales would benefit from this approach, such as the City of Calgary. Whereas rural utility-scale PV systems show the greatest benefits overall: producing a large amount of power for much cheaper than traditional sources, even in sparsely populated areas (NREL, 2012).

Using NREL's vast literature research on the topic, and with data from Statistics Canada, municipalities involved, and public electricity producers, a custom GIS tool will be created to efficiently calculate and produce accurate estimates for PV systems, by location. This custom tool will be refined and then scaled into an online platform, where the public can readily gain insight into the real cost and economic viability of solar energy, from any device. Decision makers will also be able to use the service to produce more detailed estimates with the use of higher resolution data.

For this document, a basemap was created from the high-resolution data obtained for the City of Airdrie (the project scope, covered in the next section); a sample of which can be found below, with a larger resolution file included with this document.

Figure 1 - City of Airdrie composite image; Aerial Photography from 2015, with a Digital Elevation Surface underlay; the building outlines, roads, and hydrology are shown with polygons.

2 – Scope

To ensure the project will be completed on time, and at a high level of quality, the scope was limited to the City of Airdrie; it has ample solar resources, is dense enough, and is still a comparatively small municipality to assess both Rooftop PV and rural utility-scale PV systems. Also, high resolution elevation data is available to the public – essential information for accurate GIS-based solar energy estimates.

Only two main deliverables will be produced from this project, as a result of the limited scope: the custom solar energy estimation tool, and the solar energy estimation online app. The former will only be useable by GIS professionals, and will provide powerful analytical capabilities to the municipalities with the technical capabilities. The latter, the online app, will harness as much of the analytical power of the custom tool as possible, without taxing server loads, or losing accessibility and ease of use, to ensure even a home-owner with little knowledge of solar energy can use it.

Limiting the scope to the City of Airdrie allows more time for testing and refinements, and will be easier to assess the impact of sharing the economic feasibility of solar energy.

3 – Assumptions and Constraints

With the scope limited to an approachable scale, a few assumptions and constraints arise. Assumptions are kept to a minimum, to ensure accurate information is produced; yet, are still necessary to produce results, such as the number of solar panels needed based on incoming solar irradiation, or the overall efficiency of a system. As for constraining factors, only one limits this project to a large degree: time.

3.1 Solar Energy Estimate Assumptions

Solar energy estimates are done with a few assumptions, and may affect the accuracy of the information produced from our process. To minimize accuracy losses, our model will be based on previous research from the NREL; where they tested their solar energy estimation model (PVWatts) thoroughly, with data from around the world (NREL, 2014). Their estimates have a low margin of error when compared to the real world, and hence, our project will reference their documentation for system calculation assumptions.

Our final deliverables should have implemented their recommendations for module inputs, solar resource, sun position, tracking, plane-of-array irradiance, module cover, thermal model, module model, system losses, inverter model, and model output. These will be detailed in the documentation included with the final deliverables of this project.

3.2 Project Time Constraint

All deliverables must be completed by August 5, 2016. This only allows for around 2 months of work on this project, and, as a result, will make time management critical to the success of this project. To ensure tasks are scheduled and completed in an organized fashion, Microsoft Project is used to track time.

4 – Task Descriptions

This section details the major tasks that will be completed in order to produce the final deliverables. For more information about this project's tasks, the Microsoft Project file (SEEP_TaskManagement.mpp) contains the full list and schedule.

Project Selection and Planning – Group meeting to decide on the topic of our project. This meeting will also begin refining the scope of the project.

Project Proposal – Explore the scope and potential shortcomings of our project in writing. Proposal allows us to see what we have implemented thus far, and what needs to be added.

Project Documentation – Discuss the expectations of the group with respects to the final requirement. This will also include the development of the project plan, schedule, timesheets and basemap.

Data Capture – Discuss the data that will be required for our project. Is it available? Is it accessible? Is it affordable?

Data Needs Assessment and Inventory – Explore the data and documents that we have and discuss what additional data may be required.

Data Management – Discuss how our project's data will be handled and stored.

Project Data Structure – Implementations of geodatabases and folder management.

Data Analysis – This will begin with a meeting to discuss our data analysis methodology. We will also discuss validation techniques, the construction of our custom tool and application creation.

Prepare and Practice Presentation – Includes brainstorming how to maximize the effect of a live-demonstration. This is crucial as it shows our project in action and should highlight its overall value.

Data Output – Discuss what we will be producing and in what format.

Draft Presentation – This section is crucial. It is here where we will discuss how we plan to present our project. It is important to consider comprehensibility and strategies to capture and maintain audience attention.

Draft Poster – Discuss and design overall layout and goal of the poster. Like everything else, it should be comprehensive and highlight the value of the project.

Draft report – The report will include all the information about our assignment, such as: Rationale, Recommendations, Project analysis and results, and concluding thoughts.

Draft Folder Structure – This is crucial for organization and data integrity purposes. It is here that we will discuss our folder structure and ensure that everyone has a thorough understanding.

Project and Main Deliverables – Discuss the final deliverables for our project and a review of each.

Final Poster – After considering all feedback and reviews, a final update will be implemented.

Final Report – After considering all feedback and reviews, updates will be made to the final report to reflect these.

Final Folder Structure – After the draft folder structure has received feedback, updates will be made and finalized as a deliverable.

Project Closure – Discuss overall findings and reflect on the project.

Project Management Closure Report – Create a lessons learned assessment in order to promote skill development. This section also includes client approval and peer evaluation.

5 – Role Descriptions and Responsibilities

For this project there will be three main roles to fill: Technical Lead, Project Management and Project Administration. Although these roles are defined, each member of the group is responsible for all aspects of the project.

David Bouchard is the Technical Lead and is responsible for the general technical aspects of the project. This includes determining if new technologies are needed, if the project is within our technical skill and if not what we need to do to achieve our goals.

Josh is the Project Administrator and is responsible for ensuring that the project is moving along smoothly. The duties will range from group conflict management to making sure that everyone has the appropriate information that they need.

Nick is the Project Manager and will be responsible for organizing/assigning tasks to be completed by individuals. Also the Project Manager will make sure everyone is aware of important deadlines and which components of the project have priority.

As previously stated these roles have been assigned but the entire group has the responsibility to perform all tasks as needed.

6 – Schedule

As mentioned earlier, timely completion of tasks is critical for this project's completion. Microsoft Project will be used to track tasks and deadlines; it also automatically schedules based on resource availability. It has produced a tentative schedule to keep us ahead of schedule the whole project, allowing for some scheduling margins of error. A view of the main tasks and their due dates can be seen in the figure below.

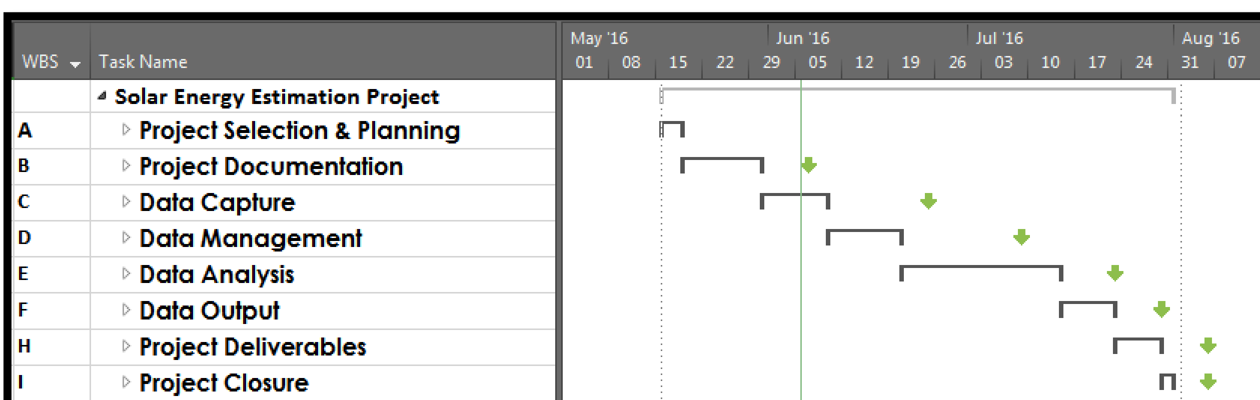

Figure 2 - Tentative Project Schedule, produced in Microsoft Project

For more information on the project's schedule, please review the provided Microsoft Project file (SEEP_TaskManagement.mpp). It contains the task list, their assigned resources, and the timeline of the project.

7 – Risk Management Plan

Our previous Solar Feasibility Study handled risks smoothly, and so we modelled a new Risk Management Plan after the old one, and refined it to handle the new challenges we might face during this project. The table below outlines the possible risks we might encounter, and how we will accept or mitigate them.

Table - Refined Risk Management Plan for the Solar Energy Estimation Project titled 'Discover Your Potential'

Risk	Likelihood	Impact	Action	Solution
Data Management				
Poor data storage	Medium	Minor	Mitigation	Create folders for data and regularly go through folders to make sure appropriate data is within
Poor file structure	Low	Significant	Mitigation	Create file structure for data and geodatabases
Improper Naming Conventions	Low	Moderate	Mitigation	Set guidelines for naming, QA/QC of folders and files to make sure naming is consistent
Data Corruption	Low	Moderate	Mitigation/ Acceptance	Have backups of all data, move on from corrupt data
Data Acquisition				
Data falls outside project scope	Medium	Moderate	Mitigation/ Acceptance	Acquire more accurate data for the scope of the project, if the data does not exist use what has been found and change project scope
Poor resolution of imagery data	Low	Moderate	Mitigation/ Acceptance	Look for more detailed resolution image, if none can be found use current imagery
Unable to locate the required census or energy data	Low	Significant	Transference	Request information from appropriate contact
Data Analysis				
Computational Errors	Low	Low	Acceptance	Recheck calculations and inputs
Use of pre-existing solar studies for cost analysis	Low	Significant	Mitigation/ Acceptance	Acquire information from reputable sources, assume that the information is correct for our study purposes
Data Output				
Difficulties using Open-Source Online Platforms	Medium	Moderate	Mitigation	Continue on the ArcGIS platform, producing the web app on ArcGIS Online

8 – Performance Measurement and Quality Management

Throughout the lifespan of the project quality will be controlled by several stages of reviews as well as inspections of the data going into the project. To ensure a high level of quality is maintained all work done be each individual member of the group will be reviewed by the other group members, and amendments will be made as a group. This will primarily apply to written documents but also will apply to work done for the project. Reviews will occur for all major milestones of the project (Project Documentation, Data Capture, Data Management, Data Analysis, Data Output, Project Deliverables, and Project Closure) and all reviews will be done by each group member. The reviews will happen in a timely manner before the due date of a milestone, as the continuation of the project will not occur until said review and update of work has been accomplished.

9 – Deliverables & Conclusion

The deliverables for this project: a web based map that will allow users to input their address and receive information regarding solar energy for their home; a custom solar energy estimation tool for ArcGIS; and the project documentation to be completed at specific milestones dates. There will be other parameters that can be input as well, but the base settings will assume that the individual wants to go off of the power grid and the information will reflect that. As the project progresses features maybe added or removed depending on the difficulty, but the original concept will not be changed, and can be used by inputting an address.

Since this project is mostly process-driven, and now has a defined schedule of completion, it should proceed smoothly, and produce high quality deliverables for the stakeholders – the City of Airdrie and their citizens.

10 – References

Black, N., Bouchard, D. Lewendon, J. (2016). Are You Wasting Your Potential? – A Solar Feasibility Study for Calgary, AB.

International Energy Agency (IEA). (2015). Snapshot of Global Photovoltaic Markets – 2015. Retrieved from http://www.iea-pvps.org/fileadmin/dam/public/report/PICS/IEA-PVPS_-__A_Snapshot_of_Global_PV_-_1992-2015_-_Final_2_02.pdf on Jun 1, 2016.

National Aeronautics and Space Administration (NASA). (2015). NuSTAR Stares at the Sun. Retrieved from http://www.nasa.gov/jpl/pia19821/nustar-stares-at-the-sun on May 20, 2016.

National Renewable Energy Laboratory (NREL). (2012). U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis. Retrieved from: http://www.nrel.gov/docs/fy12osti/51946.pdf on May 24, 2016.

National Renewable Energy Laboratory (NREL). (2014). Photovoltaic System Pricing Trends. Retrieved from http://www.nrel.gov/docs/fy14osti/62558.pdf . on May 21, 2016.

National Renewable Energy Laboratory (NREL). (2014). PVWatts Version 5 Manual. Retrieved from: http://www.nrel.gov/docs/fy14osti/62641.pdf on Jun 1, 2016.

Statistics Canada. (2015). Table 127-009 – Installed generating capacity, by class of electricity producer, annual (kilowatts), CANSIM. [Database]. Retrieved from http://www5.statcan.gc.ca/cansim/a26 on May 31, 2016.