EXPANDING SASKATCHEWAN'S WIND ENERGY: ANALYSIS OF SITE SELECTION & DESIGN

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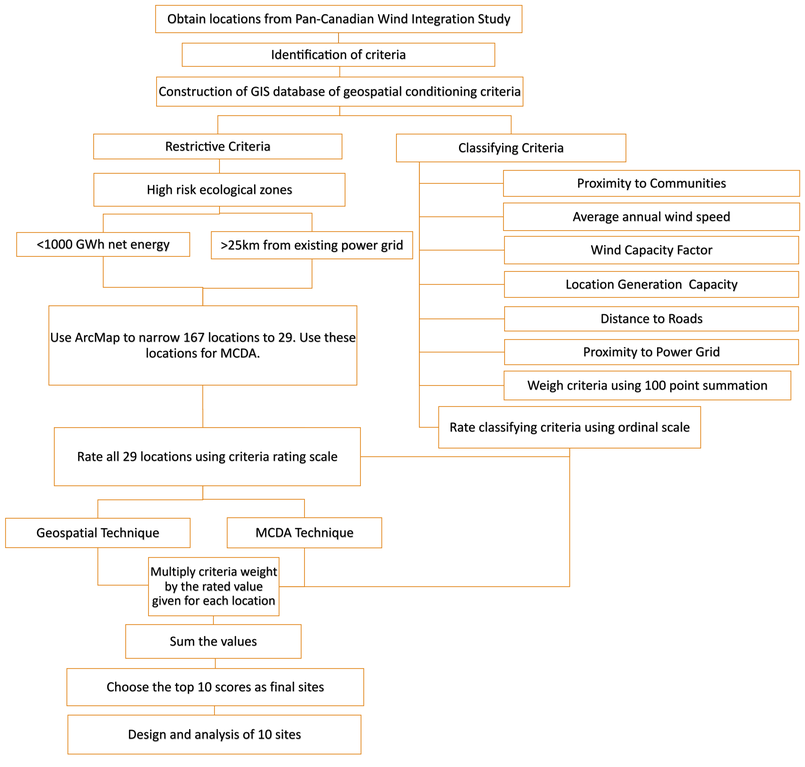
PROJECT OBJECTIVE

The purpose of this project is to create a comprehensive plan to support SaskPower's renewable energy goal of 2100 MW of wind power capacity by 2030. The main objective is to determine the optimal wind power plant locations within Saskatchewan based upon technical, environmental, and economic criteria. Secondly, a preliminary site design for the selected locations will be included which indicates the power generation at each site. A comprehensive Environmental Impact Assessment will then be completed; which will incorporate iterative analytical methods to determine the hypothetical environmental and socio-economic effects associated with the wind power plants. Lastly, a stakeholder analysis will be completed with recommendations for community engagement to address some of the foreseeable concerns of stakeholders. The objectives combine together to create a systems engineering approach for wind power plant development in the province.

SITE SELECTION METHODOLOGY

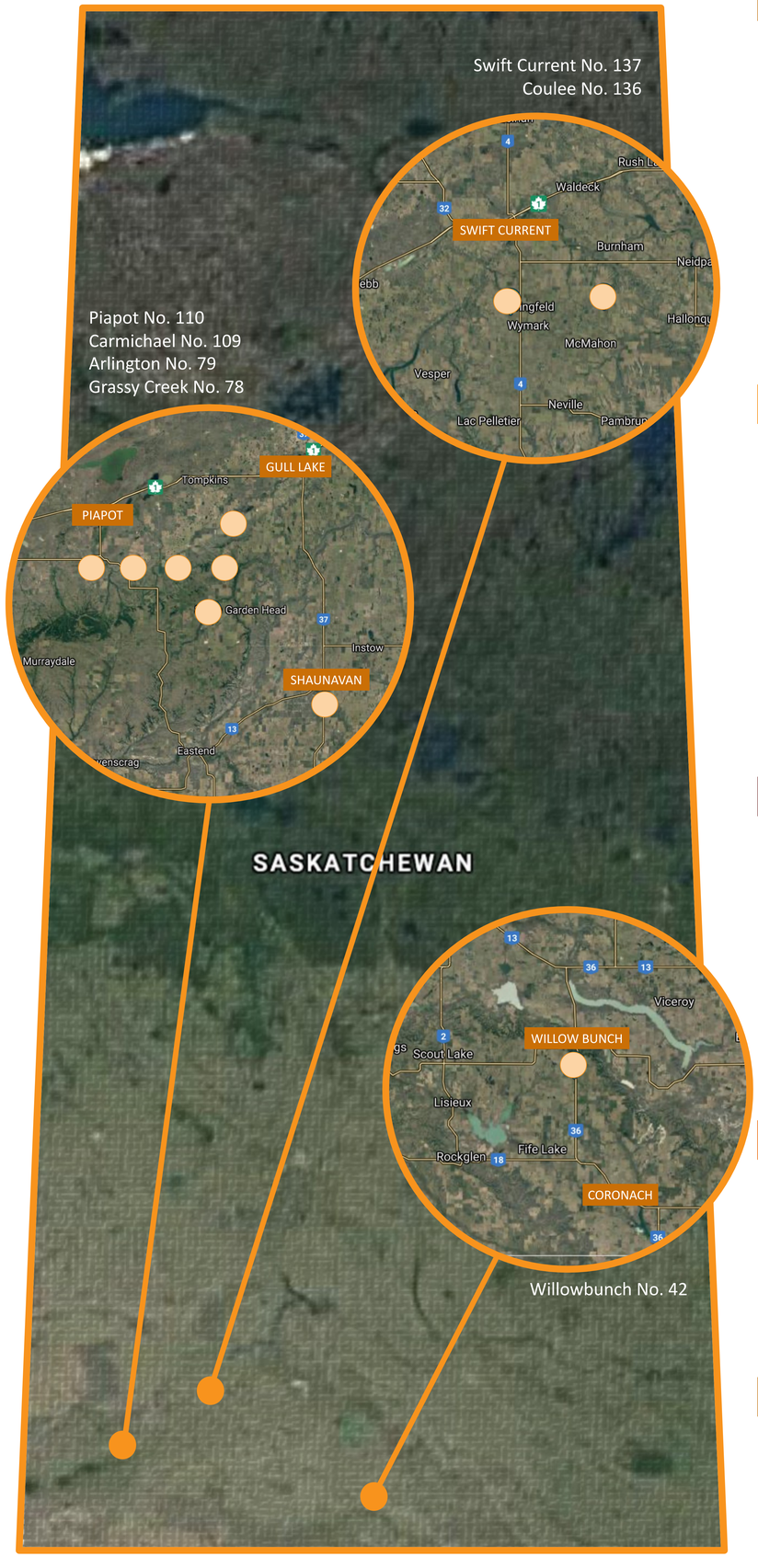
In order to appropriately analyze the province of Saskatchewan for the most optimal wind power plant locations based on eight criteria designed by the project group, the methodology chosen is the Multiple Criteria Decision Analysis (MCDA) model. The methodology follows a logical step based approach as shown in the MCDA flowchart below. Upon obtaining data locations from the Pan-Canadian Wind Integration Study (PCWIS), the criteria was defined and the 167 locations were narrowed to 29 locations using the restrictive criteria by using geospatial analysis in ArcMap. Further, the criteria were rated and applied to the remaining 29 locations to classify each location based on how well it meets the criteria rating. The criteria were weighed against each other using a 100 point summation score. The criteria weights were applied to the rating scores for each location and summed to obtain the final score. The top 10 scores were chosen as the top 10 site locations.



SITE DESIGN

Site design had 3 main components: turbine selection, preliminary design, and power analysis. The V136-4.2MW™ turbine was chosen based on specifications and previous use in the province. A preliminary site map was drawn for one site, based on a 100 km^2 area (as laid out in PCWIS) and 7-diameter turbine spacing. Terrain analysis was used to efficiently identify the best turbine locations within each area. The same process could be used on all the sites. The total power and energy available at each site was determined based on the rated power of the turbine and capacity factor of each site. The number of turbines at each site was set at 50 in order to meet the goal. The selected power plants combine to generate 2100 MW (rated) and 785 MW (actual).

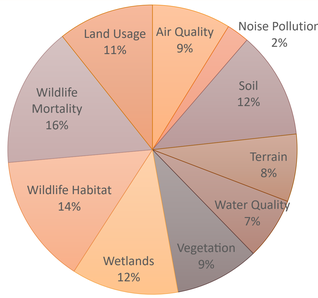
Site ID #	Capacity Factor (%)	Rated Turbine Power (MW)	Estimated Turbine Power (MW)	Estimated Power (MW)	Rated Power (MW)	Estimated Annual Energy (GWh)
2375	0.37	4.2	1.5468	77.3387	210	677.9512
2156	0.38	4.2	1.5846	79.2290	210	694.5210
1863	0.38	4.2	1.5892	79.4579	210	696.5277
2450	0.37	4.2	1.5571	77.8529	210	682.4583
2373	0.37	4.2	1.5468	77.3395	210	677.9583
2372	0.38	4.2	1.5970	79.8514	210	699.9778
2566	0.38	4.2	1.5779	78.8942	210	691.5866
2374	0.37	4.2	1.5739	78.6963	210	689.8517
2307	0.38	4.2	1.5952	79.7597	210	699.1735
2568	0.36	4.2	1.5273	76.3662	210	669.4260
			TOTAL	784.7858	2100	6879.4321



ENVIRONMENTAL IMPACT ASSESSMENT

The Environmental Impact Assessment (EIA) is a comprehensive analysis of the various environmental and socio-economic effects associated with the proposed development of the wind power plants. The EIA was conducted based on Saskatchewan Prairie land and was completed through the following steps:

- Identification of environmental and socio-economic valued components (VCs) and their associated key indicators.
- Acknowledgement of the baseline conditions and associated temporal and spatial boundaries of the project.
- Identification of any potential alterations to the baseline conditions due to the project development.
- Assessment of the project impacts, including: residual and cumulative effects, magnitude/significance determination.
- Recommended mitigation efforts and monitoring measures.



The EIA implemented the use of matrices to assist with impact prediction and magnitude modeling. The results from the analysis can be seen in the figure above. As indicated, the greatest impact is anticipated to be wildlife mortality, followed closely by wildlife habitat. This is due to the nature of wind power plants being hazardous to migratory birds, as well as the construction phase placing wildlife and wildlife habitat at risk.

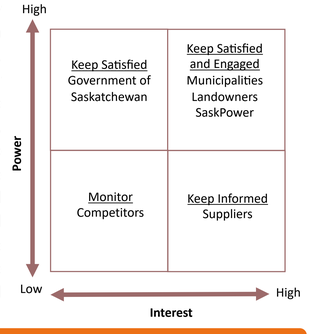
MITIGATION MEASURES

Mitigation measures are a means of reducing, or possibly avoiding the impacts associated with a project. Measures that were taken into consideration include: standard practice within the industry, regulatory compliance, activity planning, and site-specific measures. The preferred method to manage the environmental impacts is avoidance, however, this is not always a possibility. Avoidance often requires significant funding which makes it unfeasible within the project constraints. When avoidance was not an option, mitigation was the next most desirable choice to control the inevitable impacts of the project. Mitigation is the process of reducing the severity or significance of the impact. Remediation involves the acknowledgement that the impact is unable to be avoided or mitigated, thus efforts will be made to reverse or minimize the impacts after the fact. Lastly, compensation was used in circumstances involving stakeholders who are impacted by the project. A table of the affected VCs with the recommended management action can be found in the table below:

Category	Valued Component	Action
Land Disturbance	Vegetation	Mitigation/Avoidance
	Soil Erosion	Mitigation
Wildlife	Wildlife Habitat	Mitigation/Avoidance
	Wildlife Mortality	Mitigation
Sensory	Visual Aesthetic	Mitigation
	Noise Pollution	Mitigation
Socio-economic	Land Usage	Mitigation/Compensation

STAKEHOLDER ANALYSIS

The objective of performing a stakeholder analysis is to identify key stakeholders, as well as to develop engagement strategies which effectively promote the implementation of the wind power plant. Completing an analysis identifies some of the conflicts that may occur with the introduction of the project. The external stakeholders were identified and include: the Government of Saskatchewan, SaskPower, Municipalities, Landowners, Competitors, and Suppliers. In order to determine the level of engagement required for project success, the stakeholders have been organized based on the amount of power and interest they have in the project (see adjacent figure). Landowners and municipalities often have valuable insight regarding the location of the plant. The community will be more likely to accept the project if they are involved in the development process. Therefore, the project team should prioritize engaging with the stakeholders to increase the project success.



CONCLUSION

This project presents how Saskatchewan's wind energy sector can be expanded to meet the 2030 SaskPower renewable energy target. A multi-criteria decision analysis was used to identify the top ten locations for wind power plants within the province. Next, a preliminary design was conducted which included 50 turbines per site to achieve the energy production goal. An Environmental Impact Assessment was completed which analyzed these locations for the potential impacts associated with the project. The identified impacts were then addressed with recommended mitigation measures. Lastly, the stakeholder analysis was used to outline key stakeholders and suggest strategies for the integration of the project within the communities. This project utilized high-level analysis to determine the ideal locations for wind power plants within the province, as well as included a series of steps which are critical to a project development plan. Ultimately, these ten sites are considered to have great potential for wind power plants and could be used to increase renewable energy production within the province.

ACKNOWLEDGEMENTS

The project team would like to express our gratitude towards the following individuals for their constant support and guidance through the completion of this project:

- Dr. Gordon Huang (University of Regina)
- Jiapei Chen & Xiaoyue Zhang (University of Regina)
- Andrew Munro (SaskPower)
- Lara Ludwig (SaskPower)
- Grant Ring (SaskPower)