THE PROSPECT OF LARGE-SCALE CENTRALIZED PV FARMS IN SOUTHERN ALBERTA

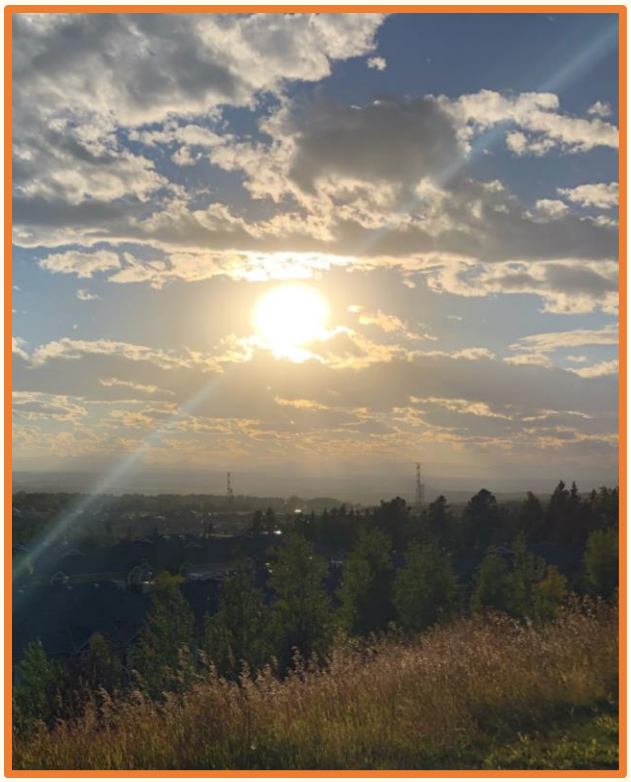

Figure 1: Author's Photo of Sun in Alberta

Solar Energy is both a safe and renewable resource with lots of potential. With Canada only contributing 1% of the worlds capacity of solar photovoltaics (PV) [1] there is lots of room for growth.

Southern Alberta has the economic feasibility, high irradiation, and PV power potential, as well as fair weather conditions, for large-scale centralized PV farms. When compared to world leaders in solar power such as Germany, Southern Alberta has a competitive potential for this renewable resource [2].

What would be the effects of a large, centralized PV farm in Southern Alberta?

The potential for solar farms in southern Alberta is high, and the solar contribution to the power grid in Alberta is likely to grow in the future. Solar farms will become larger and more common across southern Alberta as investment and confidence in the industry grows. Rystad energy predicts that Alberta will overtake the other provinces in renewable energy generation, with solar power generation expected to rise from 0.1 gigawatts to 1.8 gigawatts by 2025 [3]. What might these solar farms look like, and what effect could large centralized solar farms have?

The Greengate Travers Solar Project in Vulcan County, Alberta will be the largest solar power project in Canada upon its completion in 2022, and makes a perfect model for analyzing the potential impacts of large solar farms [4]. At a cost of 500M, it is expected to produce 400 megawatts of power, and 800 gigawatt hours per year [5]. This is enough to power over 111,000 homes and is expected to last for 35 years. The farm will require a significant amount of land, covering 4700 acres with 1.5 million individual solar panels [4]. With 7 million acres of wheat harvested in Alberta in 2017 [6], this shows that solar farms do not have a significant impact on agricultural yields in the province. This solar farm will have obvious economic benefits to the province and surrounding area. The project will create 200 construction jobs, and as many as 12 full time jobs after completion. Also, property taxes will provide $4,000,000 of revenue to Vulcan county [7]. The potential environmental impacts of the farm are also notable. The power produced is enough to offset 472,000 tons of greenhouse gas emissions annually according to Greengate [4]. The developed land could have minor effects on wildlife habitats and bird migratory patterns. Overall, the benefits of the Travers Solar Project far outweigh the risks.

How do solar projects compare to other current power generation projects? The Site C energy project in BC will be a large hydroelectric dam on the peace river expected to generate 1,100 megawatts and 5,100 gigawatt hours per year. The project will cost an estimated 9 billion and is expected to last at least 100 years [8]. This is 18 times the cost of the Travers Solar Project, providing six times the energy. However, the Site C dam is likely to far outlive large solar projects and is a more consistent source of energy compared to solar. Another comparison can be made with the Cascade natural gas power project to be constructed in Edson, Alberta. This project is expected to generate 900 megawatts and cost 1.5 billion [9]. This is cheaper and more consistent than solar, however offsets significantly less greenhouse gases.

What is the feasibility of a PV farm in Southern Alberta?

Electricity generation plays an important role in the economy of the province. In recent years, government incentives and social movements have pushed for the adoption of renewables as sustainable sources for electricity. Alberta's economy relies heavily on the oil and gas industry. 91% of the electricity generated in Alberta is produced from fossil fuels [10]. Only less than 1% percent is generated through solar. Then what is the feasibility of PV farms and how will they help Alberta's economy transition to renewables?

For a province in need of an economic transition plan, solar energy projects represent an important stimulus to the economy. They will create jobs in the areas of manufacturing, construction, operations, and maintenance. With the benefit of positioning

Alberta as a leader in a sector that is increasingly more relevant worldwide. There are currently 17 centralized PV farm projects under development. Most of these projects are expected to be completed within the next 3 years. Their total estimated cost is $1,702,800,000 and they will add 1156.6 MW of power to the grid [11].

Another benefit of centralized PV farms is the impact they will have in the adoption of solar energy as a main source of electricity. PV farms are less expensive to install and operate than rooftop solar systems. According to the Solar Energy Industries Association: Solar Market Insight Report [12], the average cost of installing a residential solar system is 2.83 $US/W, while non-residential and utility solar farms can average between 0.82 $US/W and 1.36 $US/W. This difference in price will make solar energy more accessible and affordable for people who do not have the financial means to install a solar rooftop system at their house.

When compared to other electricity generation sources, solar has become more competitive in recent years. In an analysis done by Natural Resources Canada in 2017 [13], the average capital cost of operation of solar was 1,790 $CAD/kW. The capital cost of natural gas combined cycle was 1,471 $CAD/kW. The difference is 319 $CAD/kW. With the advancements in technology and factoring in scale, the costs of operating and maintaining a solar farm will continue to drop. The reduction in cost will provide Alberta with competitive clean energy for the years to come.

How does weather impact solar power in Southern Alberta?

Solar Power is affected greatly by the weather. As one can imagine, solar panels do not work great when it is cloudy, however it is not just clouding that affects solar panels. Anything that gets in between the solar panel and the sun will affect the solar cells ability to produce energy. This will also include the atmosphere itself, fog or even dust collected on the surface of the cell.

On cloudy days, most modern solar cells are sensitive enough to still produce energy. Solar panels can still absorb the diffused light that passes through the clouds. However, this is still less energy than if the received light were direct. A standard solar cell can lose between 10-25 percent of the energy it would receive if it were sunny [14]. When looking at major Canadian cities, on average Alberta has the lowest amount of days with cloud coverage as seen in figure 2 [15]. This makes Alberta a good candidate for a PV farm.

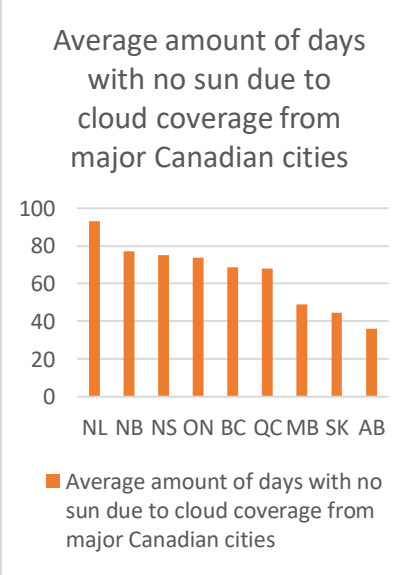

Figure 2: Average amount of days with no sun due to cloud coverage from major Canadian cities. Source: [15].

As the amount of light, the solar cell receives is particularly important, how many hours there are of sunlight is a determining factor to the output power from a cell. On shorter days, a cell will produce less energy than on longer days. Throughout the day, the amount of solar radiation the earth receives at a given location from the sun changes as the sun's angle with the surface changes throughout the day. Peak Sun hours are the hours throughout the day where the irradiance on the earth's surface is more than 1,000 Watts per m^2. The Peak Solar Hours can vary greatly depending on the location and so should be factored in when choosing a location for a solar farm. In Canada, southern Alberta and southern Saskatchewan get some of the most peak solar hours in the country [16] and would thus be ideal places for solar farms.

It might seem like solar panels are not particularly useful during the winter because of the snow. However, snowfall causes minimal loss in efficiency because sun rays can forward scatter through snow [17], so it is not that much of a concern.

Why consider Southern Alberta for a large-scale centralized PV farm?

Alberta is far from the equator and prone to cold weather, so why would it be a good place for a large-scale centralized PV farm? What might come as a surprise to some, PV cells are more efficient in colder temperatures like those seen in Alberta [18]. In temperatures above 25C PV cells will start to overheat and lose efficiency [19]. Therefore, colder weather is actually a reason why a PV farm in Southern Alberta would be a good idea. But what about the radiation from the sun in Southern Alberta? Is it strong enough?

Global Horizontal Irradiation (GHI), measured in kWh/m2, can be used to evaluate the radiation from the sun per unit area over an hour [20]. GHI is a combination of both diffused and direct solar radiation on a surface horizontal to the ground [20]. On average, Lethbridge in Southern Alberta has a GHI of 3.941 kWh/m2 [21] which is much higher than the GHI of world leaders in solar power like Germany (2.98 kWh/m2) [22] and Japan (3.61 kWh/m2) [23]. The fact that Southern Alberta has a higher GHI than some of the world leaders in solar power indicates that the radiation from the sun is strong enough to consider a large-scale centralized PV farm in Southern Alberta.

Another important factor when considering Southern Alberta for a PV farm is the Photovoltaic (PV) Power Potential. PV Power Potential refers to the energy in kWh a system produces over the power in kW of the solar panel. Within Canada, Saskatchewan has the largest PV power potential with 1330 kWh/kW/yr [24], followed by Alberta with a PV power potential of 1276 kWh/kW/yr [24]. With the second highest potential in the Country, Alberta is a good place to consider for a PV farm especially given the fact that world leaders in solar energy, such as Germany, have a much smaller PV

Power Potential in comparison [2]. The high number of sunshine hours in Southern Alberta is another reason why a PV farm should be considered in the area. When compared to Central or Northern Alberta, Southern Alberta gets the most sunlight as displayed in Figure 3 [25].

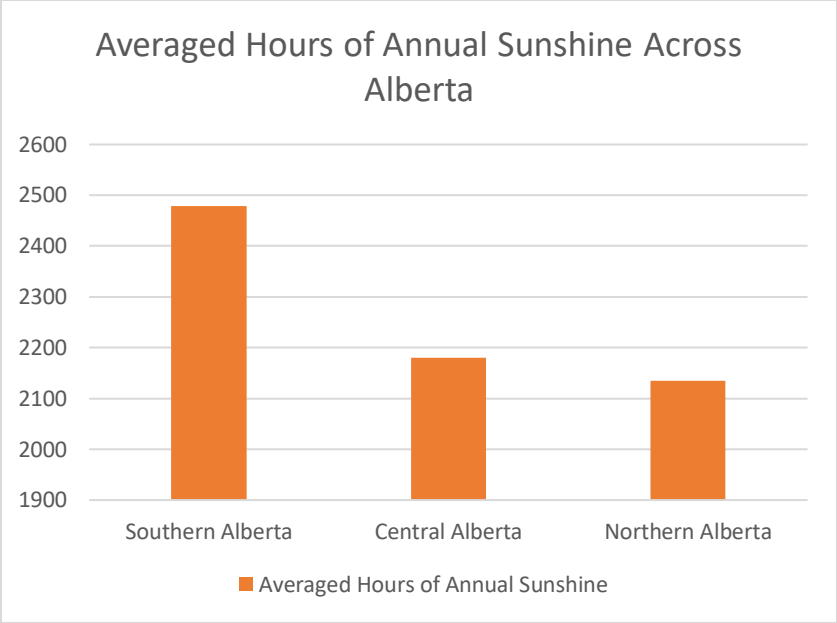

Figure 3: Averaged Hours of Annual Sunshine Across Alberta. Source: [25].

Conclusion

Southern Alberta has the potential to become the next leader in solar energy in Canada and help in the transition to renewables. Centralized PV farms in Southern Alberta will continue to improve in the coming years. The technology is becoming more efficient and cheaper making it more interesting for investors. Despite the winter, southern Alberta has excellent weather conditions, and sunlight exposure throughout the year. Solar will provide a clean and useful method to generate electricity for the province and ensure a sustainable future for the next generations.

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