Feasibility Study of Geothermal Energy Projects in Yukon with Greenhouse Agriculture

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Challenges associated with affordable, nutritious food security for Indigenous communities in Northern Canada have been documented for decades[1]. In cold and remote climates, the limiting factor for economical food production is adequate energy to maintain the temperature, light, and humidity needed for plant growth. Geothermal energy extracted from internal planetary heat is a low-carbon form of energy-on-demand[2]. This work explored the feasibility of greenhouse agriculture supported by geothermal energy to improve food security in Yukon.

A demonstration greenhouse design is provided, and two cases are considered: heating the greenhouse for use year-round, versus a lower-energy version which can grow vegetables for 10-months of the year. A first-order economic feasibility study was completed for the greenhouse; modeling the main sources and sinks of energy and estimating crop yields. The design is shown to become cost competitive versus a diesel heating alternative within 22 years (Figure 1). A comparison of the greenhouse production to the nutritional requirements of three Yukon communities was completed to forecast the impact on community food security. Further, two thermal energy supply cases were considered: one where the borehole for the geothermal ground source heat pump is purpose-drilled, and one where the greenhouse is heated by waste heat from a geothermal power plant. Results indicate that greenhouses attached to a 3-5 MW power plant could provide as many as a million servings of vegetables yearly to nearby communities, while reducing CO_2 emissions (Figure 2).

A review of the legislative and regulatory barriers of community-based geothermal projects optimized with greenhouse agriculture was conducted. Additionally, this study completed a review of potential funding sources that could offset initial high capital costs of geothermal energy projects. Further studies are needed to determine if greenhouse agriculture may provide increased social license towards geothermal energy projects.

Word Count: 293

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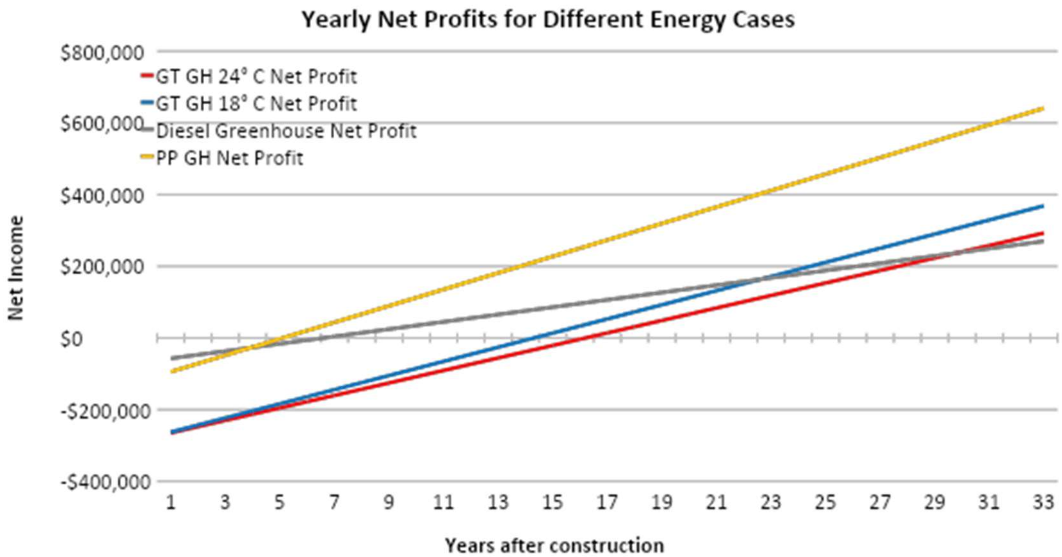

Figure 1: Yearly Net Profits for four different energy cases. Zero crossings on $0 axis represent ROI terms. Geothermal greenhouses, shown in blue and red, become cost competitive 22 years after construction. Power plant ROI is exclusive of CAPEX for plant. GT GH stands for Geothermal Greenhouse; PP GH = Power plant greenhouse, or a single greenhouse heated by waste heat.

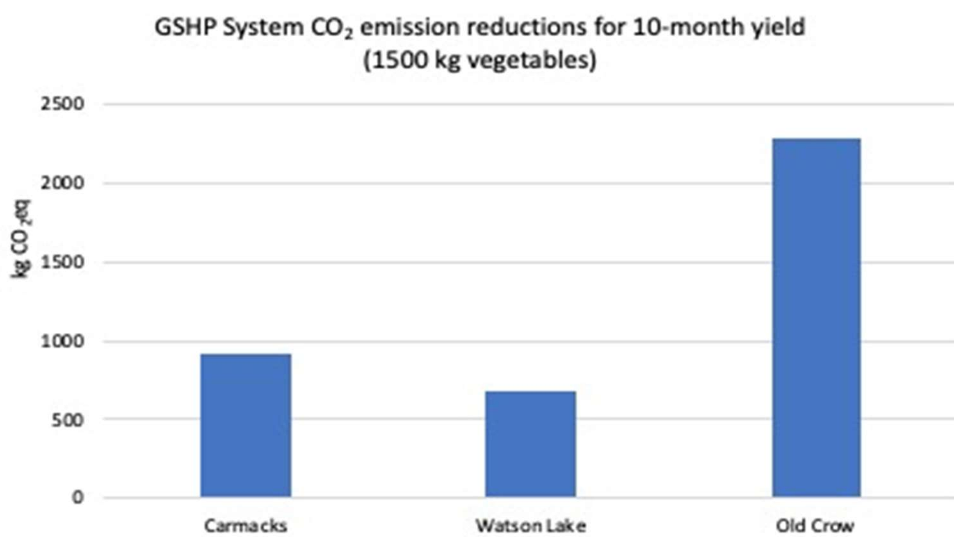

Figure 2: GSHP System CO_2 emission reductions for a 10-month yield across three greenhouse locations. Results indicate that reductions in CO_2 occur at all locations.

Acknowledgements

Authors are scholarship recipients of CREATE REDEVELOP Grant #386133824, a collaborative research and training experience in responsible energy development funded by NSERC. We would like to extend a special thank you to Dr. Celia Kennedy, Dr. Jennifer Winter, Jeanine Vany, Dr. Robert Shcherbakov, Chief Sharleen Gale, and all REDEVELOP members for their guidance throughout this project.

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