### Thesis Prospectus 2022-23

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**Student Final Submission (date):**

**Faculty Reader Approval (date):**

**MES Director Approval (date):**

1. Working title of your thesis[[1]](#endnote-1).

100 percent solar power by 2050; a case study utilizing GIS and solar mapping for Portland Oregon

1. In 250 words or less, summarize the key background information needed to understand your research problem and question.

On January 27, 2021, President Joe Biden issued an executive order setting a goal of zero net emissions country wide by the year 2050 (Exec. Order No. 14008, 2021). Rooftop solar is an underutilized resource in large cities where they have a high density of rooftop coverage.

Solar mapping is used to estimate the potential an area has for generating solar electricity and has been used in project planning for years (Moreno, 2011). It uses the local climate data, along with information on the area topography to calculate an average of how much sun reaches the area in question during a given season or in a year. When combined with the solar panel and current battery efficiency you can calculate how much energy could potentially be obtained from utilizing that area.

1. State your research question(s).

Would putting solar panels on all the rooftops in Portland produce enough energy to meet the 2050 clean energy goals? What types of buildings (public, residential, commercial) would need to be covered in solar panels to meet the energy need? Do areas of Portland with different demographic and socioeconomic characteristics have different solar energy output potential? Are there rooftop solar energy policies that could also promote social equity in Portland? How do models of solar energy output that include different combinations of building ownership/use compare to each other? What do these models suggest that an optimal layout would look like for the city?

1. Situate your research problem within the relevant literature. What is the theoretical and/or practical framework of your research problem?

As solar cell technology has developed it has become more efficient at converting solar potential into electricity. First individual homes and now entire countries have looked toward harnessing the sun to ease our reliance on dirty energy sources and depend more on renewable resources. Solar mapping models have been used for project planning for years (Moreno, 2011). The premise of solar mapping is that the solar potential has the potential be converted into electricity to supplement the electrical grid. Much of the literature has concentrated purely on mapping solar potential, but Zhang et al completed a study in 2020 that considered other impacts as well. In 2020 Zhang et al completed a solar mapping study of China that included the solar potential as well as the geography of the area and impacts to the economy. They discounted any land that was under construction, forested, agricultural, or protected.

The premise of my research is that the solar power generated from the rooftop solar panels has the potential to provide electricity for the city. I will be using building locations and structures, as well as usage types when conducting my research.

1. Explain the significance of this research problem. Why is this research important? What are the potential contributions of your work? How might your work advance scholarship?

I am studying solar mapping in Portland, Oregon to evaluate the role of utilizing solar power to meet the clean energy goals for 2050. I will be layering the solar data with geographic data to suggest placement of solar panels that has the least impact to existing ecosystems and daily living. The calculated power outputs can be used to help determine what spaces to place solar panels and if other forms of renewable energy should be considered. There needs to be more research done on what buildings solar panels would need to impact and if energy goals are feasible with the buildings that are readily available.

1. Summarize your study design[[2]](#endnote-2). If applicable, identify the key variables in your study. What is their relationship to each other? For example, which variables are you considering as independent (explanatory) and dependent (response)?

For this study I am calculating the potential average solar energy available on the rooftops of Portland and comparing it to the energy needs of the city. I am then taking into consideration the building usage types (residential, commercial, or government) to create different models of potential energy that can be harnessed using structures that are most accessible for government use.

1. Describe the data that will be the foundation of your thesis. Will you use existing data, or gather new data (or both)? Describe the process of acquiring or collecting data[[3]](#endnote-3).

My data will include location, building footprints, building usage types, geography, and climate information that is freely available through ESRI online, NOAA, the Energy Trust of Oregon, and the City of Portland.

I have found a footprint of all buildings in Portland through ESRI online that is lacking some essential meta data and so I will be asking the City of Portland if they have a better city footprint. I will also be requesting from the City of Portland a shapefile containing all government owned buildings and if they have a shapefile for building zones. I have not yet determined which solar modeling program I will run my footprint data through, but ESRI comes with an Area Solar Radiation tool that will calculate the radiation of an area if given a DSM. I need to do more research into the uncertainty involved with the tool, but it looks like the most accessible approach.

1. Summarize your methods of data analysis. If applicable, discuss any specific techniques, tests, or approaches that you will use to answer your research question.

I will be using ArcPro to complete my research. I have obtained shapefiles containing all publicly owned land parcels, building footprints, and rooftop information. I will pull out the overlap of the rooftops from the land parcel ownership shapefile. Making a shapefile for the building footprints for each type of building. Each of the three building type layers will then need to be run through the solar analysis tool to find its potential incoming solar radiation. The efficiency of the solar panels themselves will then be considered before giving potential electricity yields for the rooftop types. I will run the raw solar data through efficiency calculations to obtain potential energy output per building type. These outputs will be compared with the overall energy needs of the city. I will create three suggested models, one with only public and government owned buildings, and the two others adding in commercial or residential buildings. Each model will be evaluated on how well they meet the 2050 energy goal.

1. Address the ethical issues[[4]](#endnote-4) raised by your thesis work. Include issues such as risks to anyone involved in the research, as well as specific people or groups that might benefit from or be harmed by your thesis work, perhaps depending on your results. List any specific reviews you must complete first (e.g., Human Subjects Review or Animal Use Protocol Form).

The findings of my research could be used to influence policy decisions in the future that could target various types of properties and therefore impact different groups of people.

1. List specific research permits[[5]](#endnote-5) or permissions you need to obtain before you begin collecting data (e.g. landowner permissions, agency permits).

My research does not require any specific permits or permissions as the data I’m using is all available to the public courtesy of the City of Portland.

1. Reflect on how your positionality as a researcher could affect your results and how you will account for this in the research process[[6]](#endnote-6).

I am a graduate student in an Environmental Studies program and finding renewable energy methods that are effective and can replace ones that do environmental harm is important to me. I arrived at this thesis through my love of GIS and being able to use GIS technology to address climate concerns.

1. Provide at least a rough estimate of the costs associated with conducting your research, if any.  Provide details about each budget item so that the breakdown of the final cost is clear.

I upgraded to a TB drive for data storage

1. Provide a detailed working outline of your thesis.

100 percent solar power by 2050; a case study utilizing GIS and solar mapping for Portland Oregon

Abstract

Introduction

Literature Review

Solar program model comparisons

Mapping in urban places and site evaluations

Taking more than footprints into account

Methodology

Results

Model 1

Model 2

Model 3

Conclusion

Discussion

1. Provide a specific work plan and a timeline for each of the major tasks in the work plan. Be as realistic and specific as you can at this point, including the deadlines for Spring quarter.

Winter:

Week 2 – Jan 16 – Have the three buildings layers complete

Week 4 – Jan 30 – Solar output calculations, three models

Week 6 – Feb 13 – Introduction and lit review

Week 8 – Feb 27 – Three models complete, methodology section

Week 10 – March 13 – Have results section complete, start conclusion and discussion

Spring:

Week 2 – April 10 – Thesis draft to reader

Week 5 – “Request to Present Thesis Research” form

Week 8 – Thesis presentation

Week 9 – Final draft of thesis to reader

June 9 – Signed final thesis to MES

1. Who (if anyone), beyond your MES thesis reader, will support your thesis (in or outside of Evergreen)? Be specific about who they are and in what capacity they will support your thesis. If you are working with an outside agency or expert, be specific about their expectations for your data analysis or publication of results.

My partner and my sister will both be assisting with editing my writing. My partner will be helping with any programming if I get stuck. My cat, Sagan, will be assisting with mental support.

1. Provide the 5 most important references you have used to identify the specific questions and context of your topic, help with issues of research design and analysis, and/or provide a basis for interpretation. Annotate these references with notes on how they relate to/will be helpful for your thesis. For any other sources cited in your prospectus in other answers, provide a complete bibliographic citation here as well.

Pietras-Szewczyk, Małgorzata. “A GIS Open Source Software Application for Mapping Solar Energy Resources in Urban Areas.” *E3S Web of Conferences* 116 (2019): 00060. <https://doi.org/10.1051/e3sconf/201911600060>.

States the importance of cloud and weather data and compares the free software abilities with pricier options. Does not use current weather information.

Sachit, Mourtadha Sarhan, Helmi Zulhaidi Mohd Shafri, Ahmad Fikri Abdullah, Azmin Shakrine Mohd Rafie, and Mohamed Barakat A. Gibril. “Global Spatial Suitability Mapping of Wind and Solar Systems Using an Explainable AI-Based Approach.” *ISPRS International Journal of Geo-Information* 11, no. 8 (August 2022): 422. <https://doi.org/10.3390/ijgi11080422>.

Depending on local climates, different energies will be more appropriate. Solar needs more consistent sun since the energy storage sucks compared to the capacity.

Moreno, A., M. A. Gilabert, and B. Martínez. “Mapping Daily Global Solar Irradiation over Spain: A Comparative Study of Selected Approaches.” *Solar Energy* 85, no. 9 (September 1, 2011): 2072–84. <https://doi.org/10.1016/j.solener.2011.05.017>.

 Artificial neural networks provided the most accurate results of the three methods, non linear.

Ranalli, J., K. Calvert, M. Bayrakci Boz, and J. R. S. Brownson. “‎Toward Comprehensive Solar Energy Mapping Systems for Urban Electricity System Planning and Development.” *The Electricity Journal* 31, no. 1 (January 1, 2018): 8–15. <https://doi.org/10.1016/j.tej.2018.01.002>.

 Proposes building solar into all urban planning to assist in infrastructure design.

Zhang, Yuhu, Jing Ren, Yanru Pu, and Peng Wang. “Solar Energy Potential Assessment: A Framework to Integrate Geographic, Technological, and Economic Indices for a Potential Analysis.” *Renewable Energy* 149 (April 1, 2020): 577–86. <https://doi.org/10.1016/j.renene.2019.12.071>.

 Analyzed China for solar power placement, some high potential areas had to be reconsidered due to economic/landuse factors. They took into account a more complete picture of the geography vs just where the highest solar potential was. This is along the lines of my goals.

Exec. Order No. 14008, 19 Fed. Reg. 86 (January 27, 2021).

Loehlein, N. (2022). Buildings. [ Map]. City of Portland CGIS Group. [https://gis-pdx.opendata.arcgis.com/datasets/PDX::buildings/about](https://gis-pdx.opendata.arcgis.com/datasets/PDX%3A%3Abuildings/about)

Metro GIS. (2022). Cities. [ Map]. City of Portland CGIS Group. [https://gis-pdx.opendata.arcgis.com/datasets/PDX::city-boundaries/about](https://gis-pdx.opendata.arcgis.com/datasets/PDX%3A%3Acity-boundaries/about)

1. You are not locked into this title; we want you to identify the main point or topic of your thesis. [↑](#endnote-ref-1)
2. You might discuss selection of case studies, sampling methods, experimental design, and/or specific hypotheses you will test. You should also address any specialized knowledge or skills that are necessary to complete the research. [↑](#endnote-ref-2)
3. If you are planning to use existing data, explain the specific source, contact information, arrangement with collaborating agencies, and expectations about use of data and final products of your research. If you are planning to gather new data, describe specific methods, time, place, and equipment that will be required. [↑](#endnote-ref-3)
4. If you’re not sure where to start, consult a ‘Code of Ethics’ or other similar document from an academic society in an applicable field of study. [↑](#endnote-ref-4)
5. If you are collecting ANY samples or data, even observational data, on public lands (city, county, state and/or federal) it is your responsibility to find out the permit requirements BEFORE you collect data. Conducting research with tribal members/on tribal lands will have different and additional requirements. [↑](#endnote-ref-5)
6. Your *positionality as a researcher* refers to the fact that one’s “…beliefs, values systems, and moral stances are as fundamentally present and inseparable from the research process as [one]’s physical, virtual, or metaphorical presence when facilitating, participating and/or leading the research project…” (The Weingarten Blog 2017). [↑](#endnote-ref-6)