SLATT UNDERGRADUATE RESEARCH FELLOWSHIP
FINAL REPORT

SCHOLAR NAME:	Robert Crawford
FACULTY ADVISOR:	Professor John Onyango, PhD, '99
PROJECT PERIOD:	Winter 2020
PROJECT TITLE:	Solar Energy Potential in South Bend
CONNECTION TO ONE OR MORE ENERGY-RELATED RESEARCH AREAS (CHECK ALL THAT APPLY):	**( ) Energy Conversion and Efficiency** **( ) Sustainable and Secure Nuclear** **( ) Smart Storage and Distribution** **(X) Transformation Solar** **( ) Sustainable Bio/Fossil Fuels** **( ) Transformative Wind**

MAJOR GOALS AND ACCOMPLISHMENTS

Summarize your research goals and provide a brief statement of your accomplishments (no more than 1-2 sentences). Indicate whether you were able to accomplish your goals by estimating the percentage completed for each one. Use the next page for your written report.

RESEARCH GOALS	ACTUAL PERFORMANCE AND ACCOMPLISHMENTS	% OF GOAL COMPLETED
Determine energy savings from installing solar panels	Approximate energy consumption and production from solar panels was calculated and compared, taking into account the most influential variables. More complete measurements of solar irradiance and tree shade are required for more accurate calculations.	75%
Gather accurate readings on solar irradiance in South Bend	Pyranometer placement and readings are to be conducted in South Bend, and as such were unable to be conducted over break. Readings will be taken during the upcoming semesters.	0%

RESEARCH OUTPUT

Please provide any output that may have resulted from your research project. You may leave any and all categories blank or check with your faculty advisor if you are unsure how to respond.

CATEGORY	INFORMATION
EXTERNAL PROPOSALS SUBMITTED	(Sponsor, Project Title, PIs, Submission Date, Proposal Amount)
EXTERNAL AWARDS RECEIVED	(Sponsor, Project Title, PIs, Award Date, Award Amount)
JOURNAL ARTICLES IN PROCESS OR PUBLISHED	(Journal Name, Title, Authors, Submission Date, Publication Date, Volume #, Page #s)
BOOKS AND CHAPTERS RELATED TO YOUR RESEARCH	(Book Title, Chapter Title, Authors, Submission Date, Publication Date, Volume #, Page #s)
PUBLIC PRESENTATIONS YOU MADE ABOUT YOUR RESEARCH	(Event, Presentation Title, Presentation Date, Location)
AWARDS OR RECOGNITIONS YOU RECEIVED FOR YOUR RESEARCH PROJECT	(Purpose, Title, Date Received)
INTERNAL COLLABORATIONS FOSTERED	(Name, Organization, Purpose of Affiliation, and Frequency of Interactions)
EXTERNAL COLLABORATIONS FOSTERED	(Name, Organization, Purpose of Affiliation, and Frequency of Interactions)
WEBSITE(S) FEATURING RESEARCH PROJECT	(URL)
OTHER PRODUCTS AND SERVICES (e.g., media reports, databases, software, models, curricula, instruments, education programs, outreach for ND Energy and other groups)	(Please describe each item in detail)

RESEARCH EXPERIENCE

Please let us know what you thought of your research experience: Did this experience meet your expectations? Were lab personnel helpful and responsive to your needs? What else could have been done to improve your experience or achieve additional results?

My faculty advisor, Professor Onyango, was very helpful in not only directing my research, but also explaining the importance behind the fundamental questions and concepts of the project. I found the research process pushed my understanding of solar energy and its relationship to residential energy use. In particular, I became more acquainted with technical terms and statistical normalcies within the field of solar energy.

FINAL WRITTEN REPORT

Proposed Solar Panel Installation

The primary goal of this project was to determine the energy savings that could be produced by retrofitting solar panels on the roofs of HUD-owned apartment buildings in South Bend. Roof dimensions and angles were taken from Google Maps and other GIS maps. Particular attention was paid to roof features that would prevent solar panel installation, including chimneys and vents. The position of nearby trees was also marked in order to know which solar panels would be partially in shade (Fig. 1).

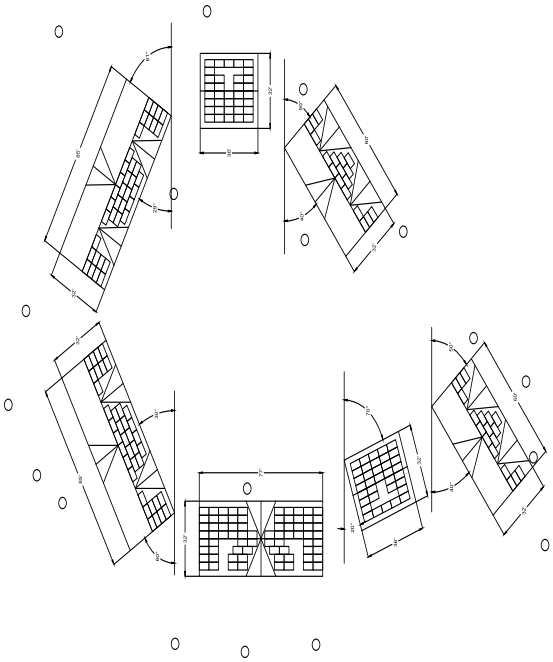

Fig. 1. Diagram showing proposed location for solar panel installation. Houses are numbered 1-7, beginning with the southernmost house, moving counterclockwise. Angles from horizontal are noted, as well as dimensions. Location of pertinent trees is represented by circles.

The selection of solar panels was influenced primarily by cell efficiency, which correlates to the amount of solar irradiation that is converted into usable energy. The proposed solar panels are SunPower A-Series 420W panels, which feature monocrystalline cells that operate at 22.5% efficiency, the highest available efficiency in the residential solar panel market.

Using the National Renewable Energy Laboratory's PVWatts Calculator, the average energy production of each individual unit's solar panel system was determined, taking into account the location, roof slope, azimuth, number of panels, panel efficiency, and system efficiency (assumed to be about 85%). The shade produced by certain trees was also estimated and taken into consideration.

The average expected output from each unit's solar panel system was then compared to average energy consumption of rented apartments in the Mid-West (Fig. 2). The data shows that the proposed installation would provide just over 85% of the energy normally used in these apartments. Certain buildings, because of the available south-facing roof space and the lack of shade from nearby trees, would be able to provide more energy than they use and are therefore better candidates for retrofitting (Fig. 3).

House Number	Avg Annual Electricity Consumption (kWh)	Avg Annual System Electricity Production (kWh)
House 1	11334	4585
House 2	11334	6418
House 3	11334	13397
House 4	22668	9782
House 5	22668	19515
House 6	22668	26540
House 7	11334	16658
TOTAL	113340	96895

Fig. 1. Table comparing the average expected energy use of each apartment building to the average expected energy production from the proposed addition of panels. Retrofitting these apartments with SunPower A-Series 420W solar panels could produce more than 85% of the energy they use.

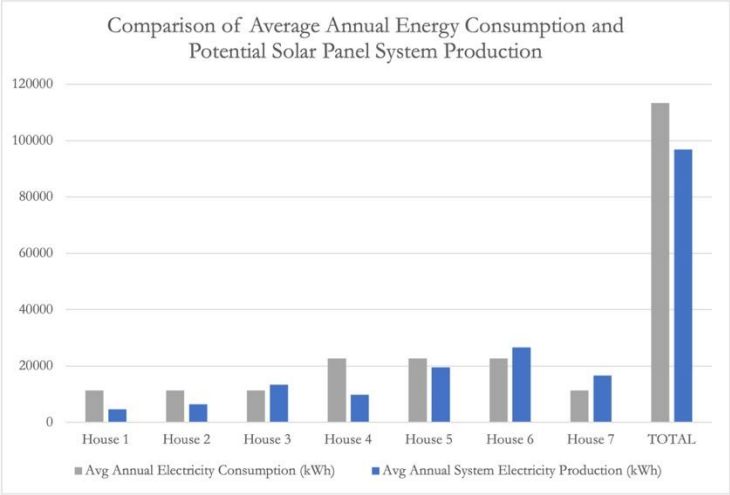

Fig. 3. Bar graph visualizing the relationship between average annual energy consumption and potential solar panel production per apartment building. Some houses, particularly those without much tree cover—houses 3, 5, 6, and 7—would likely be able to offset their electricity consumption through the proposed installation.

Future Steps

The average solar irradiation data used in this project was taken from reliable sources, but a more accurate reading would be helpful in considering the impact of this proposal and future proposals in South Bend, Indiana. Using a pyranometer, solar irradiance within the city of South Bend will be determined over a period of months. Notes will be made especially upon the differences between cloudy and sunny days.

This project was conducted to understand more about renewable energy sources, which are vital to the well-being of our planet. While such a mindset is beneficial in many ways, the cost of installation and its economic benefits are also important to consider. Further research would examine the cost efficiency of installing solar systems, with particular attention to the possibility of installing cheaper but less effective panels, as well as placing panels only in those areas unaffected by shade.