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SITES PRIORITIZATION OF COMMERCIAL SOLAR PHOTOVOLTAIC SYSTEMS USING GIS RESOURCES IN MASSACHUSETTS

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SOLARFLAIR ENERGY INC:
SITES PRIORITIZATION OF COMMERCIAL SOLAR PHOTOVOLTAIC SYSTEMS
USING GIS RESOURCES IN MASSACHUSETTS

ZIFENG LI

MAY 2016

A MASTER'S PROJECT

Submitted to the faculty of Clark University, Worcester,
Massachusetts, in partial fulfillment of the requirements for
the degree of Masters of Science in the department of International Development,
Community, and Environment

Accepted on the recommendation of

Jie Tian, Chief Instructor

ABSTRACT

SITES PRIORITIZATION OF COMMERCIAL SOLAR PHOTOVOLTAIC SYSTEMS USING GIS RESOURCES IN MASSACHUSETTS

ZIFENG LI

My summer internship at SolarFlair Energy Inc. was conducted from May 20 to August 21 in 2015, where I cooperated with two supervisors for my work; Dodge A. Travis and Daniel T. Greenwood. I was working as a Geographic Information Science analyst to help generate business and sell commercial solar panel systems. By using available GIS databases to assess viable sites for solar installations, analyzing sites using and prioritizing potential sites through multi-criteria analysis, I successfully generate business lists for a variety of towns in Massachusetts, including Boston, Springfield, Newton, Woburn, Quincy, Brookline, etc. This internship was an invaluable experience that made me familiar with the application of GIS in commercial business and enhance the GIS skills acquired from coursework. The following chapter have provided a detailed discussion of SolarFlair Energy Inc., my work and overall feelings.

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Chief Instructor

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(7/2013-6/2014)

DEDICATION

This final paper is dedicated to my professors and colleagues who have supported me throughout my academic pursuits, as well as my intelligent fellow GISDE classmates.

ACKNOWLEDGEMENTS

I would like to thank Jie Tian for his help throughout my time at Clark. Served my professor, academic advisor and mentor, he has been providing advice and support to me, which has always been guiding and a spotlight for my forwards on my career goals.

I would also like to thank Yelena Ogneva-Himmelberger, who has given me lots of evaluable experience and suggestions in academic and industry.

Finally, I would like to thank Dodge A. Travis for his help and friendship. And also thank my boss Daniel T. Greenwood for allowing me working at SolarFlair Energy Inc.

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CHAPTER 1: INTRODUCTION

I conducted a fulfilling internship this summer. My initial plan was to pursue a Ph.-D degree in Geographic Information Science or Remote Sensing after graduating from Clark. While I found myself more interested in devoting myself to work after graduation, I started looking for an internship online, on sites like Indeed, Simply-Hired and LinkedIn at the begin of April. Several interviews did come but no further progress was made. My colleague Dodge Travis, majoring in ESP and MBA at Clark, who was working at SolarFlair Energy Inc. in the meantime, gave me a call and offered to hire me as GIS Analyst. SolarFlair Energy Inc., which is a commercial business located in Ashland, Massachusetts, provided me with a three-month internship from May 20 to August 21, 2015. My primary responsibility was to assist the commercial business development team to generate business and sell commercial solar photovoltaic systems using GIS resources.

The following Chapter will talk about SolarFlair Energy Inc. in details, including the organization's mission, its structure, strengths and how does it accomplish its mission. Chapter 3 will discuss my internship responsibilities, how I my work connect to the organization's mission and show several my work samples. Chapter 4 will provide my assessment of the internship. Chapter 5 will close the paper with a simple conclusion.

CHAPTER 2: DESCRIPTION OF ORGANIZATION

2.1 Background and Mission

SolarFlair Energy, Inc. is Massachusetts's leader in solar consultation, design, and installation. It was founded with a mission to deliver cost effective clean energy solutions to residential and commercial clients in Massachusetts. (SolarFlair Energy, Inc.) With decades of experience in the solar energy industry and electrical power systems, they are well-equipped to serve clients. SolarFlair brings together an intimate knowledge of solar technology with creative financing mechanisms to deliver a product that will meet people's energy goals and save money. (SolarFlair Energy, Inc.) The company is located in Ashland, Massachusetts, which is a 30-minute drive from Clark University.

SolarFlair provides solar photovoltaic systems in Massachusetts. As a full-service company, they perform site evaluations, system design and installation, and provide clients with expert guidance in financing, identifying and capturing all available incentives. Massachusetts's commitment to solar energy makes it one of the most affordable places to add solar photovoltaic systems. (SolarFlair Energy, Inc.)

SolarFlair's management team is committed to solar energy and has the experience to back it up. They have decades of experience in solar photovoltaics and electrical systems, working in both commercial and residential, as well as a broad range of relevant degrees and certifications. (SolarFlair Energy, Inc.)

2.2 Organization Culture and Value

Working at SolarFlair Energy Inc., employees are supposed to effectively accomplish its mission by taking several responsibilities. They are supposed to install solar electric systems on homes and commercial buildings, interact with customers to schedule installations and inspections and work directly with Project Manager and Outside Superintendent.

Commercial solar makes great business sense. Customers can lower their current operating expenses and provide peace of mind against rising energy costs, and tap into the growing customer base that look for environmentally responsible vendors that are focused on sustainable energy strategies. (Solar for your business, SolarFlair Energy, Inc.) Government incentives combined with recent decreases in solar equipment prices make the investment in solar power a good financial decision for businesses and public agencies. An investment in solar power can generate quick payback as well as long-term savings. (Solar for your business, SolarFlair Energy, Inc.)

This company effectively demonstrates its values from five main aspects. It empowers individuals to make a switch to clean energy for powering their home, business, or institution. (SolarFlair Energy, Inc.) Also, it reduces our dependence on carbon based fuels such as oil and coal. Furthermore, it accelerates the transition to clean energy technologies so as to minimize the impacts on the global economy. To some degree, it reduces the effects of global climate change. (SolarFlair Energy, Inc.) Most importantly, it provides an opportunity for individuals (employees and customers) that are passionate about these issues to make a

tangible impact on the energy usage of the communities in which we live. (SolarFlair Energy, Inc.)

2.3 GIS Support

GIS is used to provide assistance for the solar business. Optimized locations for installing solar systems should be decided before conducting the on-site installation. As the first GIS employee at SolarFlair, I was provided an unpaid GIS consultant position to help identify the appropriate installation sites.

I did lots of maps in my GIS projects and showed the company how valuable GIS resources can be. Through applying GIS technology, lots of potential commercial centers and residential buildings can be extracted from the geodatabases which can be served to identify sites or solar panels. Using geocoding and Google Earth, optimal locations were found and solar panels will be installed.

CHAPTER 3: DESCRIBING YOUR INTERNSHIP RESPONSIBILITY

3.1 Company Mission

I am working as a GIS analyst in the marketing department at SolarFlair Energy Inc. This role requires me to assist the commercial business development team with generating leads and marketing strategies using GIS resources. As a business and commercial sale company, SolarFlair aims to deliver effective clean energy solutions to residential and commercial clients in Massachusetts, which mainly deals with solar photovoltaic and electrical systems consultation, design and installation. To complete the mission, I need to identify optimal sites for installing solar panel systems in Massachusetts. After finding these sites, potential customers may be found and the business with the panels will get promoted.

3.2 Mapping the Solar Energy Distribution in Massachusetts and Decision Making

To identify optimum sites, firstly we have to identify towns, which need more solar energy. From the attached Excel data, we can find information about solar panels from all companies, such as the installer, the installation cost and energy capacity. Hence, it is obviously easy to achieve the total solar energy capacity distributed in each town in MA. Figure 1 is an illustration of the total energy capacity of solar panels installed by different companies in each town in MA. The energy values are divided into six levels shown in graduated colors, respectively representing none, very low, low, medium, high and very high. The towns with high values are primarily located in the south and southeast, like Dartmouth, Springfield, Palmer, Warren, Boston, etc. Considering the human living conditions, Figure 2 shows the

energy capacity per individual of solar panels installed by different companies in each town. Similarly, the values can be classified into 6 different levels. Nearly all towns in MA do not have high capacity values, except for some in the central and southwest MA like Tolland, Chester and Warren. In Figure 3, the solar energy capacity is normalized by the area of each town to illustrate the energy distribution per acre, which shows us some towns with high-density like Warren, Freetown, Dartmouth and Wrentham. Figure 4 is normalized by the house unit. In conclusion, these three maps illustrate the energy capacity distribution of all solar companies in MA, we can find that towns with high solar energy are primarily located in the south and southeast, where intense competition exists. However, in other low-density towns, there may be more potential customers and business opportunities. Figure 5 and Figure 6 show us the solar energy distribution from SolarFlair Energy Inc. Figure 5 shows the total value and Figure 6 is normalized by population. The sale extent of SolarFlair Energy Inc. is really eye-catching and so is the difference in energy capacity in different towns. Based on these two maps, we can find that the sale extent is not so large in MA, and towns with high-density energy are located in the southeast. To expand our business, we need to find more potential customers and business opportunities beyond the current sale extent or in towns with low densities. Combined and compared with Figure 1, Figure 2, Figure 3 and Figure 4, we can find that several towns are extremely suitable for solar panel installation, like Quincy, Canton, Cambridge, Woburn, Medway, Dover, Mills and Needham. The next process is to extract the business lists for these towns.

3.3 Extracting Customer Lists in Decided Towns

To create the business lists, I have to use the online GIS resources. On the Massachusetts government, the Level 3 Assessor's Parcels geodatabase should be downloaded. This data will provide the site address, use type and owner information for all buildings for different towns. For our business, the commercial and industrial buildings are appropriate. After importing to the ArcMap, by using 'Select by Attribute', the use code between 300 and 500, which represents commercial and industrial buildings, are selected out as our target buildings. After exporting these data into excel, several features are kept, like states, city, site-address, owner and use_description, and the original business addresses are produced. To get the optimal sites, further editing work needs to be conducted because not all building roofs are appropriate for solar panels installation, so we need to check the appropriateness in Google Earth. First, geocoding is conducted by using the site address of buildings in the Excel through batch-geo online. Batch-Geo online is really useful and powerful, which can geocode up to 250 addresses at a time. The KML file for each town will be downloaded. Then, these KML files are opened in Google Earth for editing. In Google Earth, inappropriate addresses will get deleted. We have set strict rules for the building roof selection. They should be flat and smooth without lots of structures, like water tanks built on. They should be large enough to hold many solar panels. Furthermore, they need to face south so that more sunlight can be absorbed to provide sufficient solar energy. Figure 7 shows some good sites for installation. The optimum addresses are saved as new KML files, which can be opened in the Excel. In Excel, we can observe lots of information, like site

location, owner name, owner address, state, city and zip code. To contact the customers, we can send letters to them and find potential business opportunities. The customer list can be referred to Figure 8.

Solar Capacity in MA from all Companies

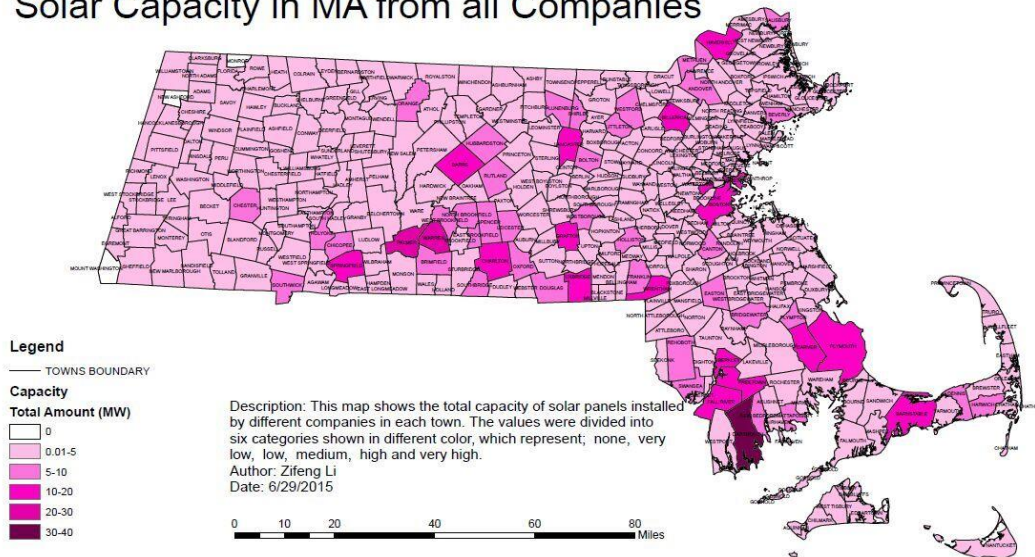


Figure 1 Solar Energy Capacity from all companies

Solar Capacity Per Acre in MA from all Companies

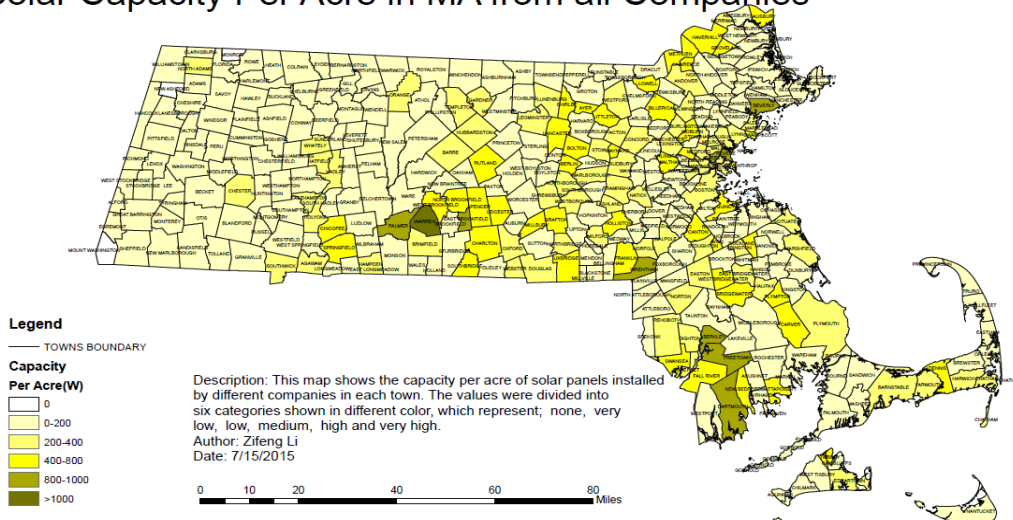


Figure 2 Solar Energy Capacity per Acre from all companies

Solar Capacity Per Individual in MA from all Companies

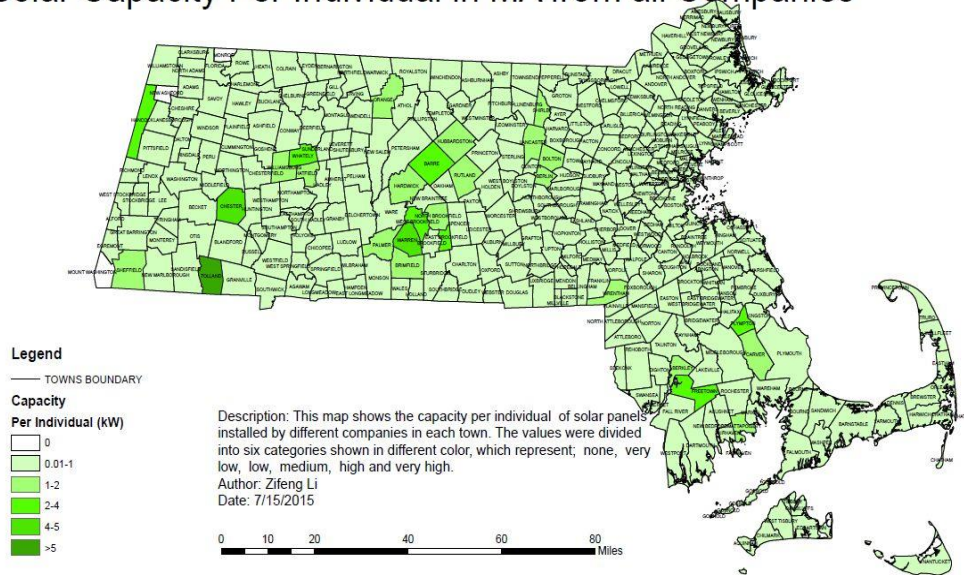


Figure 3 Solar Energy Capacity per Individual from all companies

Solar Capacity Per House Unit in MA from all Companies

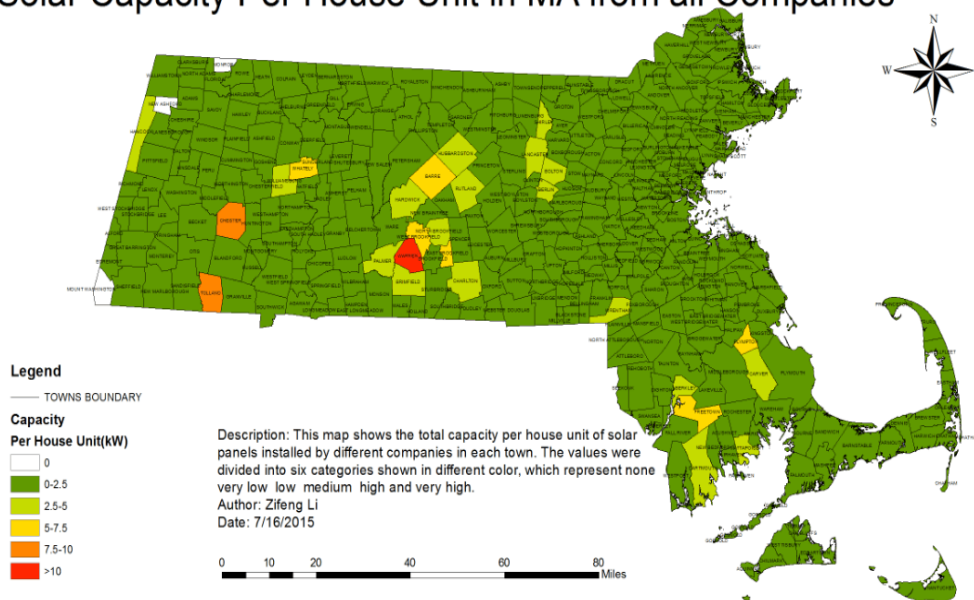


Figure 4 Solar Energy Capacity per house unit from all companies

Solar Capacity in MA from Solarflair Energy Inc.

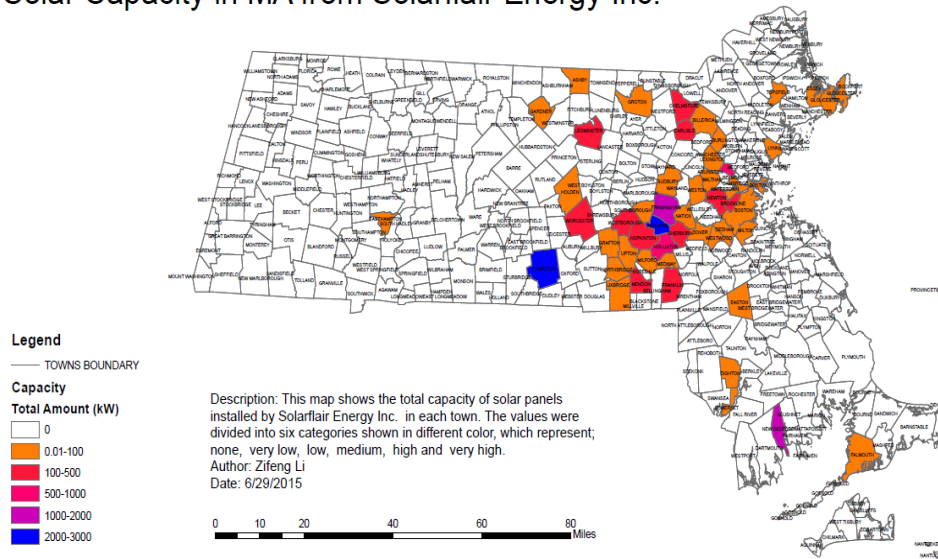


Figure 5 Solar Energy Capacity from SolarFlair Energy Inc.

Solar Capacity Per Individual in MA from Solarflair Energy Inc.

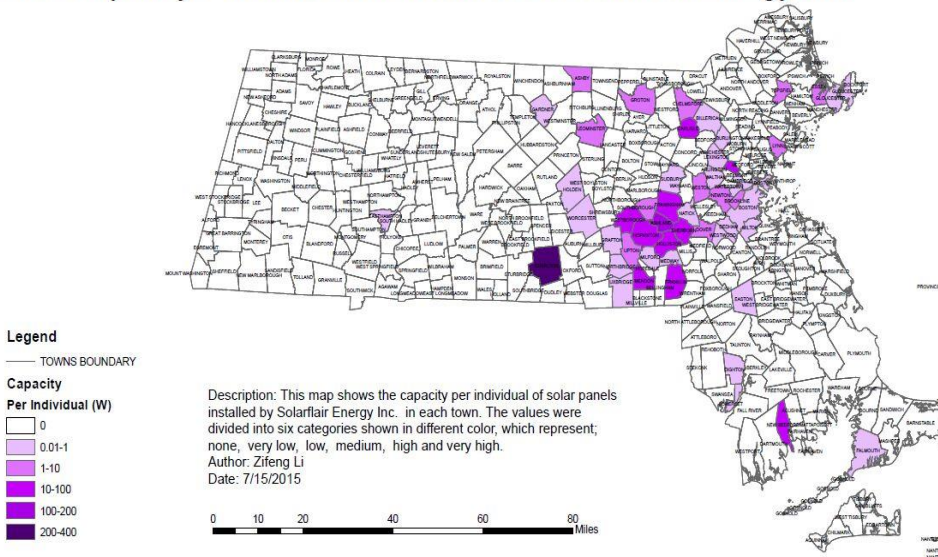


Figure 6 Solar Energy Capacity per Individual from SolarFlair Energy Inc.

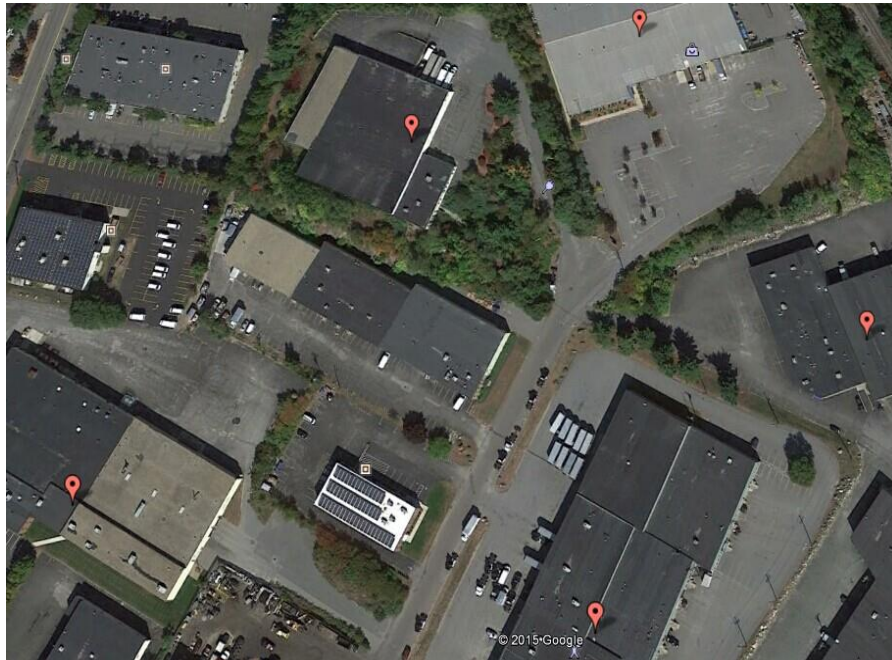


Figure 7 Site Editing in Google Earth

SITE_ADDRESS	OWNER1	OWN_ADDR	OWN_CITY	OWN_STATE	OWN_ZIP
16 EVERBERG RD, WOBURN, MA 01801	YUSEN ROBERT R. TRUSTEE	7 WAINWRIGHT RD #115	WINCHESTER	MA	01890
44 SIXTH RD, WOBURN, MA 01801	WOBURN GROUP LLC	303 CONGRESS ST	BOSTON	MA	02210
60 OLYMPIA AVE, WOBURN, MA 01801	WHITTEN GEORGE D.	39 HOLTON STREET	WINCHESTER	MA	01890
415 MAIN ST, WOBURN, MA 01801	WESTON ATLANTIC ASSOCIATES	500 LUNALILO HOME RD. 32A	HONOLULU	HI	96825
415 WILDWOOD AVE, WOBURN, MA 01801	UNITED STATIONERS	1 PARKWAY NORTH BLVD	DEERFIELD	IL	60015-2559
15 OLYMPIA AVE, WOBURN, MA 01801	UNIFIRST CORPORATION	68 JONSPIN ROAD	WILMINGTON	MA	01886
17 GILL ST, WOBURN, MA 01801	TWO L PROPERTY HOLDINGS LLC	144 SUMMER ST	WALTHAM	MA	02452
481 WILDWOOD AVE, WOBURN, MA 01801	TIGHE JOHN FSR	481 WILDWOOD AVE	WOBURN	MA	01801
25 CONN ST R WOBURN, MA 01801	STOR-U-SELF OF WOBURN LMT PARTNERSHIP	55 CAMBRIDGE STREET	BURLINGTON	MA	01803
181 NEW BOSTON ST, WOBURN, MA 01801	SCAIA JAMES FTR	P O BOX 2489	WOBURN	MA	01888
2 ELM ST, WOBURN, MA 01801	ROTHENBERG DANIEL E. TR.	1385 HANCOCK STREET	QUINCY	MA	02169
70 OLYMPIA AVE, WOBURN, MA 01801	ROHTSTEIN CORPORATION	P O BOX 2129	WOBURN	MA	01888
425 WASHINGTON ST, WOBURN, MA 01801	PRIMA IV LLC	1 JOY STREET	BOSTON	MA	02108
64 HOLTON ST, WOBURN, MA 01801	POWERSCOURT REALTY TRUST	P O BOX 609	WOBURN	MA	01801
20 CROSS ST, WOBURN, MA 01801	POCO REAL ESTATE LMT PTR	7 BOWSER ROAD	LEXINGTON	MA	02173
1 SIXTH RD, WOBURN, MA 01801	PHALANGER LLC	2 MAIN STREET	STONEHAM	MA	02180
30 NASHUA ST, WOBURN, MA 01801	PASCIUTO COSMO TR	94 HIGH STREET	WINCHESTER	MA	01890
201 CAMBRIDGE RD, WOBURN, MA 01801	OLSEN ROBERT C	82 TUDOR RD	NEEDHAM	MA	02192
10 ATLANTIC AVE, WOBURN, MA 01801	NEW MID A TERRACE TENJ LLC	155 WEST STREET	WILMINGTON	MA	01887
323 NEW BOSTON ST, WOBURN, MA 01801	NEW BOSTON STREET ASSOCIATES	P.O. BOX 3099	ANDOVER	MA	01810
42 SIXTH RD, WOBURN, MA 01801	MODA ANTONIO ETAL	P O BOX 132	WEST BOXFORD	MA	01885

Figure 8 Business Lists

CHAPTER 4: INTERNSHIP ASSESSMENT

Generally, this internship is meaningful and rewarding. I learned a lot technical skills and obtained people networks from this internship. Since Google Earth was used to assess the appropriateness of the solar panel installation position, I became more familiar with its built-in functions, such as making and deleting markers. I also acquired lots of professional skills in site choosing for solar panels. For example, buildings' roofs should be flat and large enough to hold as many panel as they can, and face south to absorb more solar energy. Mass Government GIS is a very useful website to download publicly available GIS data, such as a variety of facility layers, census tract and Level 3 Assessor's Parcels data. Additionally, in ArcGIS by extracting data, the table data is easy to be converted to Excel or text file. The XML and KML file from Google Earth can be edited in Excel. Therefore I became more proficient in data extraction and conversion. Working in industry and studying at school is very different. Now I am very professional in tracking progress of my commercial work, like writing documents to explain my tasks, generating reports to company management and making evaluations for strengths and drawbacks for the sake of improvement.

I believe my internship is highly related to one course I took in Clark. Intro to GIS is very fundamental and significant in ArcMap basics, such as select by attribute, SQL writing and data conversion. The initial data processing conducted by geocoding, which was introduced by this course, is also applied to my internship. The Excel skill I learned since college is

really applicable in data processing, like sort from A-Z and data duplicates removal, which is very useful in the business address formatting.

When I started working for the commercial business team at SolarFlair Energy, I knew nothing about the site selection for solar panel installation. For this, my supervisor, Dodge Travis, spent much time on getting me familiar with the size of solar panel, letting me know how large the ideal building roof is for panel installation. I also figured out how to visualize data in KML file and managed to generate business addresses from the KML file. Furthermore, since I got hired, I needed to learn the company's culture, and behave more professionally as a professional GIS worker, representing SolarFlair in a professional manner at all time in both appearance and communications, which includes wearing clothing with SolarFlair logo.

I worked as a GIS Analyst, which is what I am pursuing to be after graduation. This internship has helped me enhance the GIS skills I mentioned above, which are also covered in Intro to GIS. During this semester, I learned Advanced Vector GIS and got a higher level understanding on GIS analysis, such as spatial join, geographic patterns and clustering detection, and regression analysis. Currently I feel more confident about becoming a more professional GIS analyst in the future, and this internship has served as a vital foundation for my career goal.

I highly recommended this internship for other IDCE students. Although this internship is not difficult, it is enough to be a good professional training before becoming a professional GIS worker, and the combination of GIS skills and solar energy is a spotlight on their

resumes, since these two fields are increasingly relevant in people's daily lives. And also, communicating and sharing experience with people dealing with commercial sale is an expansion in people network and non-GIS knowledge. Moreover, SolarFlair is located in Ashland, where is really close to Worcester and only takes a 40 minute drive.

CHAPTER 5: CONCLUSION

Clark University has been assisting me in pursuing my future goals in the field of remote sensing and GIS. By cooperating with colleagues and professor with various backgrounds, I have become increasingly professional. The internship at SolarFlair Energy Inc. has been a really extraordinary experience, which has helped me understand how GIS is applied to other fields and solve professional complexities. I really appreciate the help from other colleagues at the company, from whom I also learned professional work attitude. I am very grateful to have gotten this internship, which has served as a bridge between the academia and professional fields. I highly recommend this opportunity to those, who are looking for a fulfilling internship.

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SolarFlair Energy Inc. Accessible Link: <http://www.solarflair.com/about/our-approach>.

SolarFlair Energy Inc. Accessible Link: <http://www.solarflair.com/start/>.