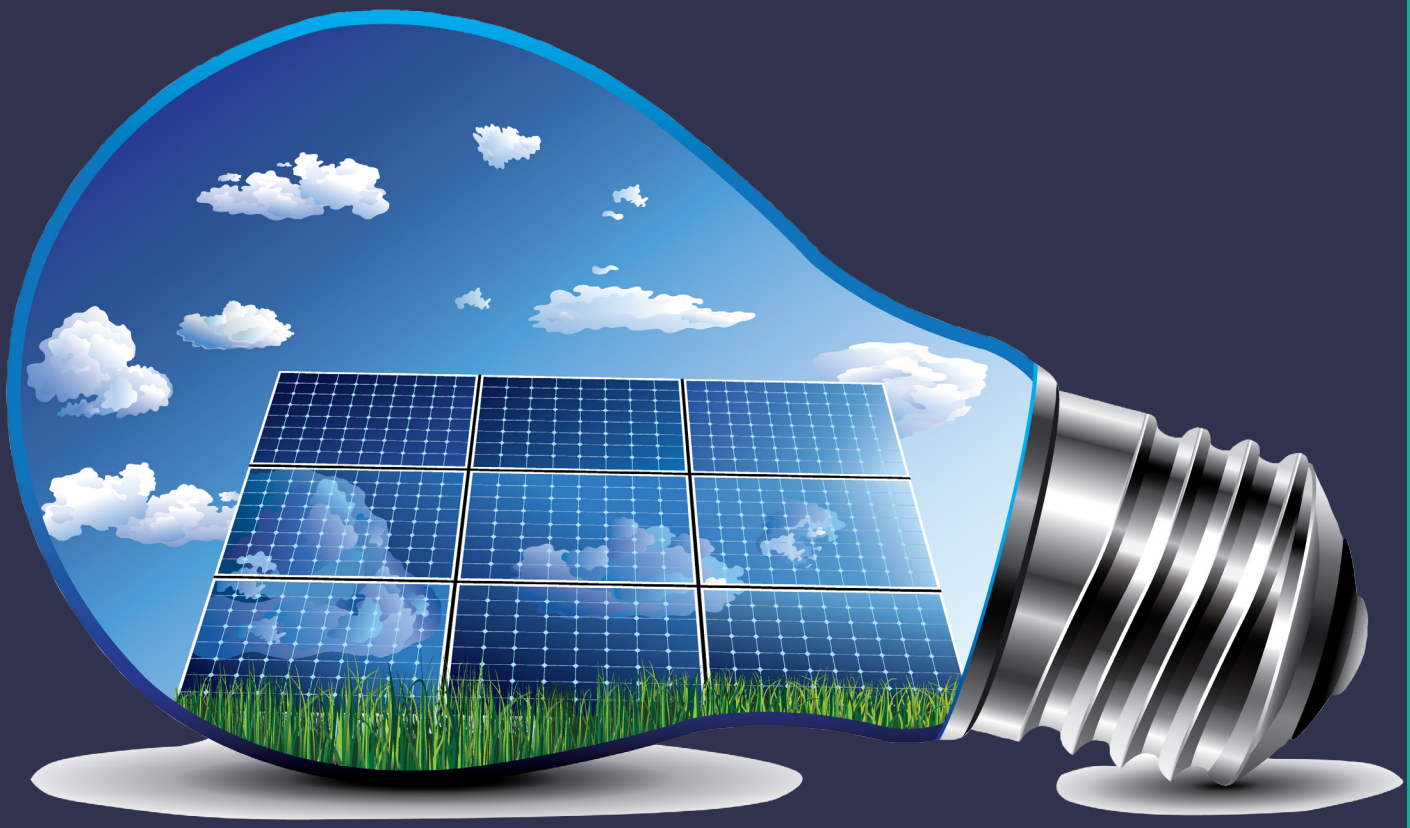


Retrofitting the Campus with Rooftop Solar

A 2015 iCAP objective

Niharika Kishore
Master of Urban Planning
University of Illinois at Urbana-Champaign
May 2017

Executive Summary

The purpose of this project is to propose a plan to implement one of the many objectives of the 2015 Illinois Climate Action Plan (iCAP). The iCAP was signed by our university in 2010, which was further updated in 2015. The objective that this project focuses on, requires the production of 12,500 MWh of solar energy on campus property by FY20. The objective also requires the production of 25,000 MWh of solar energy on campus property by FY25.

This project proposes a list of buildings on campus that are most suitable to be retrofitted with rooftop solar. Utilizing the roof-spaces of buildings is an excellent use of otherwise unutilized space, since these roof spaces do not compete with any other land-uses. The following method was employed in selecting the most suitable buildings.

Method of determining the most suitable buildings on campus for retrofitting with solar panels

A list of 17 buildings was identified which are suitable for retrofitting with rooftop solar. These buildings passed the aforementioned preliminary criterions and were therefore included further in the process. The next step was to hold meetings with the building stakeholders to address any concerns that they may have, or answer any questions regarding the next steps of the process.

A series of meetings were held during fall 2016 with each of the building stakeholders to cross-check if there was anything we needed to know to proceed ahead with the process, and to our delight, every building on the list agreed to be a part of this project. Following is the list of buildings that can help achieve our iCAP goal.

	Building	Potential Annual generation (MWh)
1.	Additional solar on Business Instructional Facility	unknown
2.	NCPD roof & structure	1,595
3.	Physical Plant Services Building	790
4.	Activities and Recreation Center	725
5.	ECE rooftop	400
6.	Law Building	395
7.	Ikenberry Dining Hall	380
8.	Digital Computer Laboratory	265
9.	Abbott Power Plant	265
10.	Disability Resources & Educational Services	185
11.	Plant Sciences Laboratory	165
12.	Timothy J. Nugent Hall	160
13.	Institute for Genomic Biology	160
14.	Richard T. Ubben Basketball Complex	150
15.	Oak Street Library	150
16.	Bousfield Hall	145
17.	Garage and Carpool	125
	TOTAL	**6,055**

Final List of Buildings

If retrofitted, these buildings can help us achieve our iCAP goal of generating 12,500 MWh/year of solar energy on campus property. The campus already possesses an annual generation of 8,300 MWh of solar energy, therefore we require 3,700 MWh/year more. This plan proposes an additional 6,055 MWh/year of solar energy on campus, thereby moving a step closer to the FY25 goal.

The next steps of this project are to seek funding (FY17), write the RFP (FY17), Request for Proposals (FY18), complete the installation (FY19), and generate 12,500 MWh/year of solar energy (FY20).

Acknowledgements

I consider this a great privilege to be given the opportunity to express a deep sense of gratitude towards my Capstone Advisor, **Professor Brian Deal** and thank him for providing guidance throughout my Master's studies at the **University of Illinois at Urbana-Champaign**.

Deepest gratitude is also due to **Ms. Morgan Johnston**, without whom this project would not have been possible. She has been the backbone of this entire project, and I would like to thank her for being there at every step. I am grateful for the invaluable guidance and support throughout the duration of my Capstone, and her constant endeavour to engage and hone my working standards.

I express a sincere gratitude towards **Ms. Mary Edwards**, who continually supported me and was available for help throughout the duration of my Master's program. This project would not have been possible without **Corey Weil** and **Brendan McDonnell**, whose survey and research of the campus buildings helped me further the project.

I take immense pleasure in thanking the entire DURP team, my family, friends, and co-workers for their support, assistance, and encouragement throughout my Master's Project.

Project Timeline

2008

Our university signed the American College and University Presidents' Climate Commitment (ACUPCC).

- A formal commitment towards achieving carbon neutrality ASAP.

2010

The 2010 Illinois Climate Action Plan (iCAP) was signed with the goals of:

- Reducing existing building energy consumption by 20%;
- Reducing existing building greenhouse gas emissions by 15%;
- Purchasing 30% of food from local sources;
- Reducing potable water usage by 20%;
- Implementing a "no net increase in space" policy; and
- Obtaining 5% of electrical energy from renewable sources.

2015

The 2010 iCAP was updated to further the goals and build upon them.

- One of the goals is to generate 12,500 MWh/year of solar energy on campus.

2017

FY17 Project development and sourcing funds.

- Meeting with potential buildings
- Seeking funding
- Writing the RFP

2018

FY18 Request for Proposals (RFP)

2019

FY19 Installation completed

2020

FY20 Obtain 12,500 MWh/year of solar energy on campus

Abbreviations Used

iCAP – Illinois Climate Action Plan

ACUPCC – American College and University Presidents' Climate Commitment

GSF – Gross Square Footage

RFP – Request for Proposal

PPA – Power Purchase Agreement

EBS – Energy Billing System

BIF – Business Instructional Facility

ECE – Electrical and Computer Engineering Building

PPSB – Physical Plant Services Building

NCPD – North Campus Parking Deck

List of Images

Table of Contents

Introduction: The 2015 Illinois Climate Action Plan (iCAP)

University of Illinois at Urbana-Champaign

Our university signed the American College and University Presidents' Climate Commitment (ACUPCC) in 2008, which is a formal commitment towards achieving carbon neutrality as soon as possible. ACUPCC is a high-visibility effort to address the issue of global warming and climate change. More than 600 colleges and universities signed this commitment which requires the annual reporting of greenhouse gas emissions inventories as well as progress reports every alternate year.

The signing of this commitment led to the realization of the urgency of mitigating climate change, and the importance of doing our bit as an institution. This further led our university to sign the 2010 Illinois Climate Action Plan (iCAP) whose goals were:

- Reducing existing building energy consumption by 20%;
- Reducing existing building greenhouse gas emissions by 15%;
- Purchasing 30% of food from local sources;
- Reducing potable water usage by 20%;
- Implementing a "no net increase in space" policy; and
- Obtaining 5% of electrical energy from renewable sources.

After five more years, our university signed the 2015 iCAP, which furthered these goals and built upon them by either restating/updating the previous targets, or adding new targets. The 2015 iCAP sets climate mitigation objectives which are required to be achieved by FY20. The 2015 iCAP encompasses the following categories which further have a number of objectives under each of them:

- Energy Conservation and Building Standards;
- Energy Generation, Purchasing, and Distribution;
- Transportation;
- Water and Stormwater;
- Purchasing, Waste, and Recycling;
- Agriculture, Land Use, Food, and Sequestration;
- Carbon Offsets;
- Financing;
- Circular Education;
- Outreach; and
- Research

Under the Energy, Generation, Purchasing, and Distribution category, one of the objectives is to expand on-campus solar energy production. The goal is to produce 12,500 MWh/year of solar energy on campus property by FY20. This represents 5% of the projected campus energy consumption in 2050. Consequently, the campus must generate 25,000 MWh/year of solar energy by FY25, which represents 10% of the projected campus energy consumption in 2050.

This project focuses on formulating a plan to achieve the FY20 target of generating 12,500 MWh/year of solar energy on campus property.

Why Rooftop Solar?

As per the USGBC, about 40% of all carbon emissions in the U.S. can be attributed to residential and commercial buildings. These emissions come from the burning of coal and combustion of fossil fuels for heating, cooling, and electrification of the buildings. The emissions from buildings in the U.S. alone account for more emissions than any other country's emissions, except for China.

Buildings expend about 70% of all electricity consumed in the U.S. This is close to about 39 quadrillion Btu as of 2016. Buildings have an extensive amount of embodied energy which culminates to about 8-10 times the annual energy used for heating and cooling the building. A building's lifespan typically is about 50-100 years in which it continually consumes electricity and produces emissions. Therefore, even if 50% of the newer constructions are built to consume 50% lesser energy, we could save 6 million metric tons of CO_2 annually. This is equivalent to removing more than 1 million cars off the road every year.

As per the 2010 iCAP, our university has agreed to limit the expansion of our campus space-wise. Therefore, new constructions would occur only sparingly. Our next best option to reduce our building's energy consumption is to retrofit them to make them more efficient. One of the options we have is retrofitting our building rooftops with solar energy so that a part of the building's energy needs could be met by cleaner energy sources.

Benefits of Rooftop Solar:

1) Retrofitting with rooftop solar is an excellent way to utilize the existing roof space.
2) It is a clean and a green source of energy – retrofitting our building rooftops with solar panels would allow our campus to obtain the iCAP objective of using clean energy sources.
3) Reduction in carbon emissions and a step closer to carbon-neutrality – Using energy produced from solar panels drastically reduces the carbon emissions of a building.
4) Fairly non-invasive process – Since the panels only require installation on the rooftops, the building use is not prohibited in any way during the installation process.
5) Solar can provide peak generation of energy during the peak electrical energy demand on campus.
6) It has zero noise pollution.
7) It requires very little maintenance.
8) Solar irradiation is fairly predictable and therefore the energy generation is predictable.
9) A number of rebates and incentives are available which could be made use of and therefore shifts our campus one step higher on the ladder to sustainability.
10) Retrofitting our buildings with rooftop solar may attract a number of students to our campus owing to the green-campus tag.
11) Generating solar energy on campus would help "green" our economy.

In lieu of the aforementioned benefits of retrofitting our buildings with solar photovoltaics, I strongly believe we should move ahead with the plan of generating 12,500 MWh/year of solar energy by FY20.

Renewable Energy Projects on Campus

Our university has several renewable energy installations as well as proposed installations within the campus area that include solar photovoltaic, solar thermal, geothermal, biomass, and wind energy generation. We also have several renewable energy certificates and green power purchase agreements.

- **Solar Energy Projects:**

  - 2010 – Business Instructional Facility: BIF has rooftop solar photovoltaic installed and produces about 45 MWh of solar energy annually.

  - 2013 – Building Research Council: Building Research Council contains ground-mounted solar photovoltaic panels and generates about 20 MWh of solar energy annually.

  - 2013 – Re_home: Has installed solar panels that produce about 9.5 MWh of solar energy annually.

  - 2014: Activities & Recreation Center: ARC has a Solar Thermal energy installation that heats water for their swimming pool.

  - 2015 – Solar Farm: The solar farm on the south campus generates about 7,800 MWh of solar energy annually.

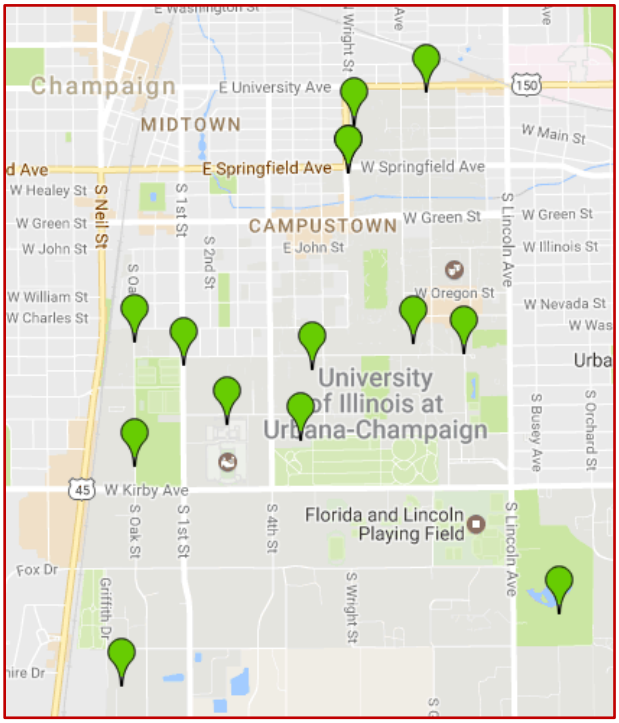


Figure 1. Map of Renewable Energy Projects on Campus

  - 2015 – Uni High Gym: The Uni High Gym has a 1 kWh dc solar array installed.

  - 2016 – Wassaja Hall: Wassaja Hall has rooftop solar photovoltaic installed and produces about 45 MWh of solar energy annually.

  - 2017 – Electrical and Computer Engineering Building (ECE): The solar installation on the ECE building is under progress and is said to generate 400 MWh of solar energy annually upon completion.

We have about 7,900 MWh/year of solar energy generation on campus already. With ECE getting commissioned this year, we will have about 8,300 MWh/year of solar energy generation on campus. To reach our iCAP goal of 12,500 MWh/year, we need to plan for the generation of an additional 4,200 MWh/year.

Year	Location	Name-plate Capacity (MW)	Annual generation (MWh)
FY10	Business Instructional Facility	0.033	45
FY13	Building Research Council	0.015	19.6
FY13	Re_home	0.007	9.3
FY14	ARC solar thermal	-	-
FY16	Solar Farm	4.758	7800
FY16	Wassaja Hall	0.03	45
FY17	Electrical and Computer Engineering	0.27	400
		Total	**8318.9**

Figure 2. Solar Already Existing on Campus

- **<u>Other Renewable Energy Projects:</u>**
    - Geothermal energy generation at Allerton Park: Allerton Park successfully installed a geothermal energy harnessing plant.
    - Biomass energy generation at the Energy Farm: This project is still underway and aims to convert biomass into power for on-site usage.
    - EPA Green Power Partner: This agreement encourages energy users to purchase green energy instead of coal-based dirty energy and therefore offsets carbon emissions.
    - Wind Power Purchase Agreement (PPA): The Urbana campus signed an agreement to receive a certain portion of wind-generated electricity, which could be used for on-campus demand.
    - Several projects that are still in the proposal phase encompass wind energy generation, biomass energy conversion, and geothermal energy generation.

Campus Energy Trends

Methodology:

Through the Energy Billing System (EBS) of the University of Illinois (Facilities & Services), the annual electric energy consumption for every building on campus for which data existed was retrieved. Then, the building electric energy consumption trends were evaluated from 2008 to 2017. The gross square footage of every building was recorded to calculate the electric energy consumption per square foot of each building. This helped in identifying the most energy intensive buildings on campus.

The energy consumed by each building was then added to estimate an annual campus energy consumption for every year. Some buildings did not have data recorded through the EBS server and therefore this analysis is based only on the data available through the EBS server.

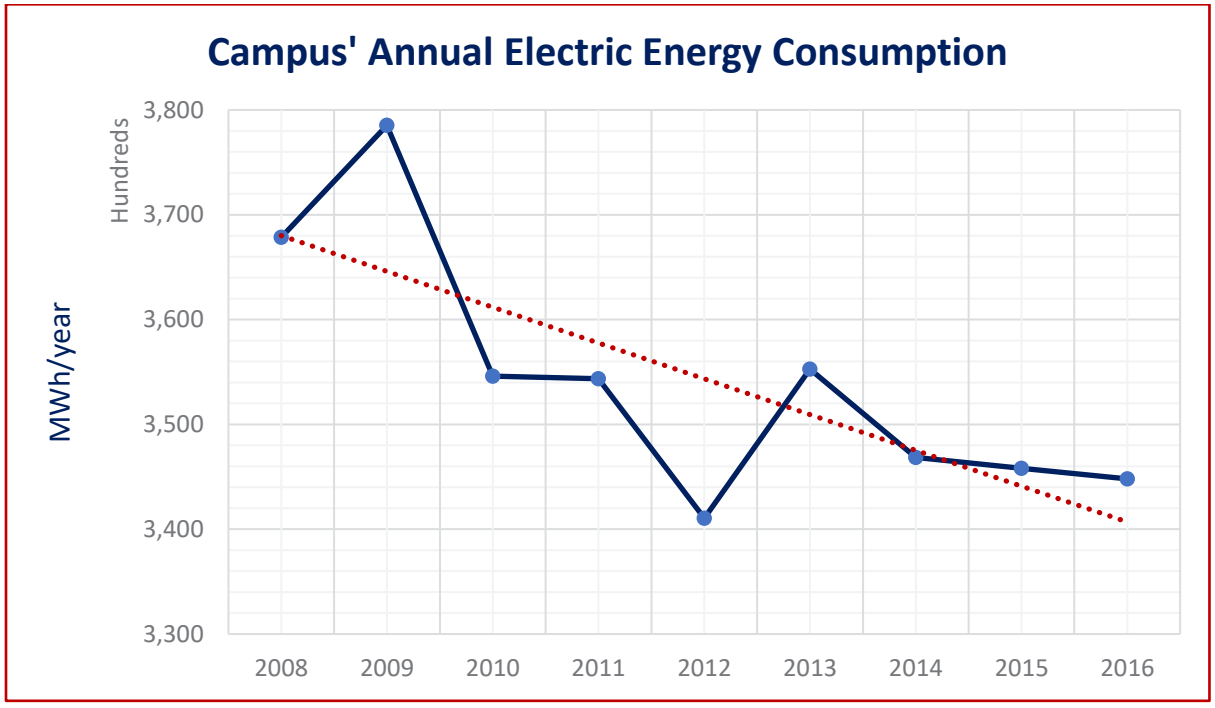


Figure 3. Annual Campus Energy Consumption Trend

As per the data, our campus is seeing a downward trend in electric energy consumption. The campus consumed about 345,000 MWh in 2016 as compared to about 368,000 MWh in 2008. As per the iCAP goal, our campus is projected to consume 250,000 MWh in 2050, furthering this downward trend.

If we consider a linear projection of the campus energy consumption, the campus is projected to consume about 340,000 MWh/year of electric energy in 2020 (as per the upper confidence bound). The iCAP goal of achieving 12,500 MWh/year of solar energy generation on campus reflects 36.8% of the projected 2020 energy demand.

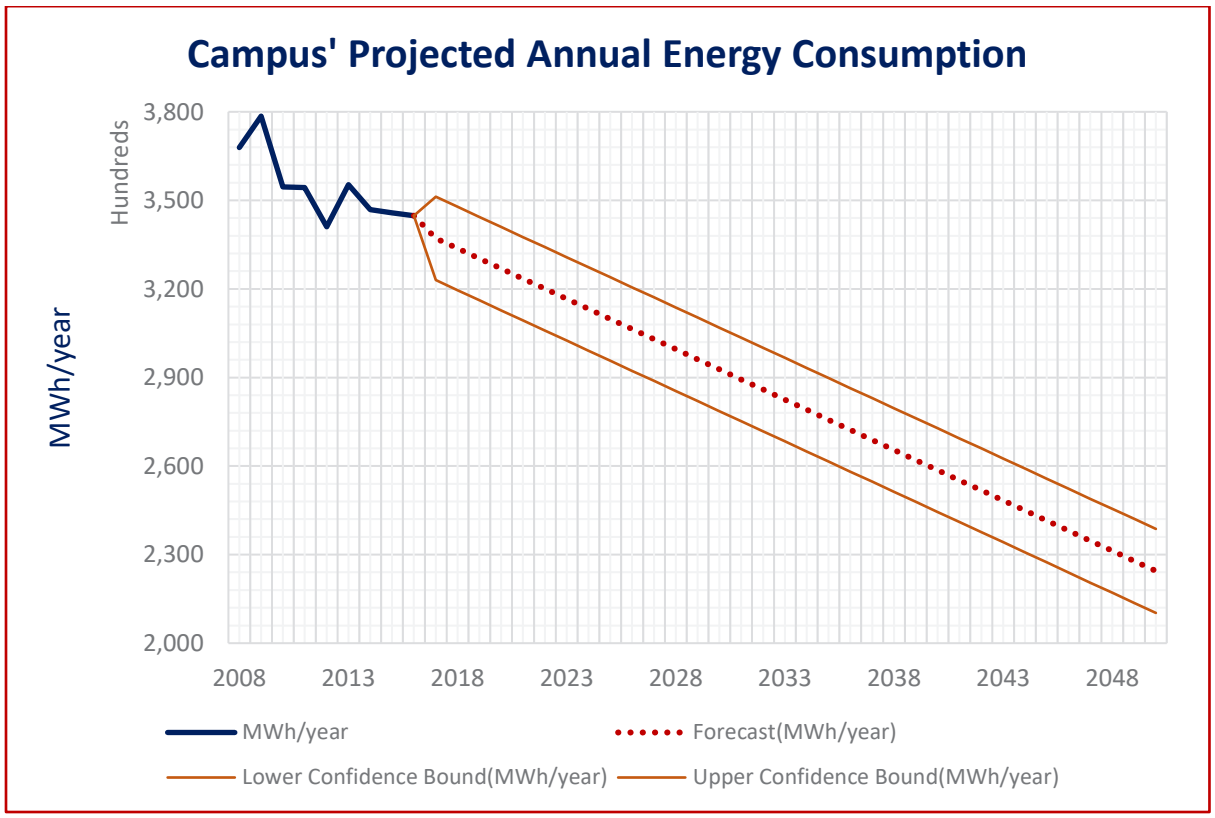


Figure 4. Projected Annual Energy Consumption Trend

Procedure for Shortlisting the Most Suitable Buildings

Methodology:

A. Based on the data from the U of I EBS server, the energy use intensity of every building on campus was calculated in terms of kWh/GSF. This gave us the list of the most energy intensive buildings on campus.

B. The building rooftop area available for solar energy generation was determined using google maps.
   - An approximate solar energy generation capacity was calculated using the PVWatts Calculator (an online software tool for calculating how much solar energy can be produced, given the size and location of the building).
   - Based on the available rooftop sizes, buildings were categorized as Large (>2000 m^2), Medium (1000-2000 m^2), and Small (<1000 m^2).
   - For further analysis, only the buildings with large rooftops were considered owing to the strategy that retrofitting a few larger buildings would be easier and faster to reach our goal of generating 12,500 MWh/year of solar energy on campus by FY20. Out of the 1,000 buildings on campus, 43 buildings qualified for this.

C. The Architecture Review Committee was given the list of 43 buildings with large rooftops for them to provide us with a preliminary cut as to whether or not a building could be included for the further purpose of shortlisting to retrofit with solar panels. The architecture review committee further reduced this to 29 buildings.

D. The building rooftop types, age, and material were analysed to further select buildings from the large rooftop category which would be most suitable for retrofitting with solar panels.

E. A set of 17 buildings was identified based on how energy intensive they were, how much solar energy generation potential they had, if the Architecture Review Committee agreed to pass them for a preliminary shortlisting process, whether their rooftops were suitable for holding the solar panels, and whether this set could collectively help us reach our iCAP goal.
   - 17 buildings made it to the list which could be retrofitted with solar panels to reach the iCAP goal of generating 12,500 MWh/year of solar energy on campus by FY20.

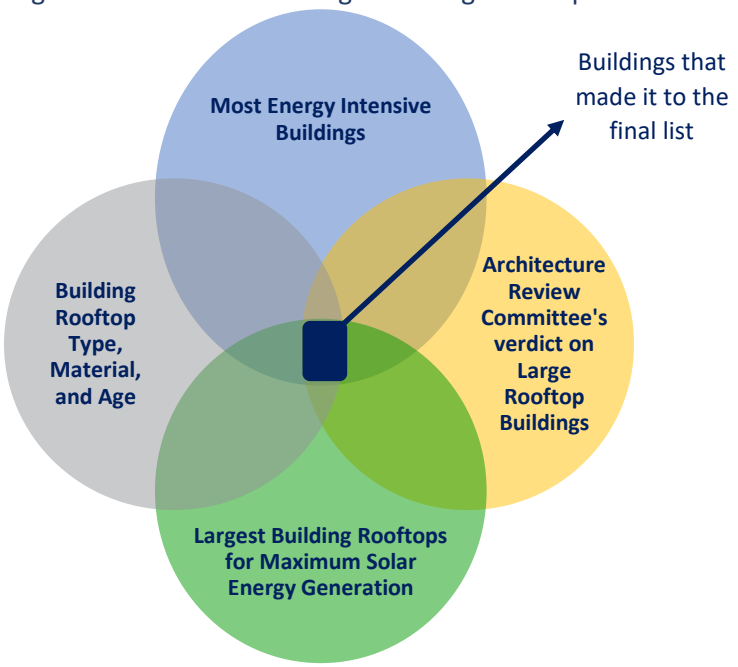


Figure 5. Building Selection Procedure

F. Meetings were arranged with the building stakeholders to ensure they are on-board with the process and that it is safe for us to include their building on the list.

A. Most Energy Intensive Buildings on Campus

	Building	Gross Square Footage	Electrical Energy Use in 2016 (kWh)	Electrical Energy Use per ft²
1.	Ice Arena	51,676	23,26,463	45
2.	Micro and Nanotechnology Laboratory	1,47,347	62,17,247	42
3.	Chemical and Life Sciences Building	2,31,316	90,19,458	39
4.	Institute for Genomic Biology	2,19,789	84,66,620	39
5.	Housing Food Stores	51,162	18,55,700	36
6.	Seitz Materials Research Laboratory	1,23,151	41,45,882	34
7.	Oak Street Library	51,308	16,86,741	33
8.	Plant Sciences Laboratory	1,00,848	27,25,355	27
9.	Mechanical Engineering Building	1,00,518	25,84,055	26
10.	Newmark Civil Engineering Building	2,08,959	50,47,401	24
11.	Richard T. Ubben Basketball Complex	39,067	8,90,400	23
12.	Atkins Tennis Center	68,812	14,20,240	21
13.	Engineering Sciences Building	1,07,724	20,36,729	19
14.	Vet. Medicine Basic Sciences Building	2,59,413	47,52,435	18
15.	Timothy J. Nugent Hall	1,15,517	20,94,930	18
16.	Ikenberry Dining Hall	1,39,557	24,48,379	18
17.	Digital Computer Laboratory	1,94,280	33,62,598	17
18.	Veterinary Teaching Hospital	2,33,703	39,22,305	17
19.	Loomis Laboratory of Physics	1,75,513	28,16,063	16
20.	Natural Resources Studies Annex	65,416	9,67,512	15
21.	Foreign Languages Building	1,17,715	15,23,440	13
22.	Illini Union	3,05,130	38,96,481	13
23.	Mechanical Engineering Laboratory	1,51,860	18,77,456	12
24.	Education Building	94,059	11,29,616	12
25.	Campus Recreation Center - East	1,04,575	11,83,985	11
26.	Physical Plant Services Building	1,62,883	17,73,613	11
27.	Rehabilitation Education Center (DRES)	42,080	4,56,936	11
28.	Garage and Car Pool	27,395	2,93,144	11
29.	Electrical and Computer Engineering	2,38,390	24,91,586	10
30.	Music Building	1,05,343	9,14,665	9
31.	Agricultural Engineering Sciences Building	1,06,019	9,03,173	9
32.	Law Building	1,89,730	15,45,153	8
33.	Allen Residence Hall	1,57,023	12,15,268	8
34.	Bousfield Hall	1,86,114	14,09,036	8
35.	Business Instructional Facility	1,62,251	11,95,196	7
36.	Activities and Recreation Center	4,42,235	30,32,277	7
37.	Huff Hall	1,82,536	12,29,492	7
38.	Everitt Electricity & Computer Engineering Laboratory	1,24,246	6,67,648	5
39.	Krannert Art Museum	62,440	3,35,304	5
40.	Armory	2,58,510	12,03,493	5
41.	F-29 Parking Deck	2,53,669	8,36,951	3
42.	North Campus Parking Deck	5,21,441	14,86,760	3
43.	Abbott Power Plant	1,94,896	unknown	unknown

B. Largest Available Rooftops for Generating Solar Energy

	Building	Gross Square Footage	Available Roof Area (ft^2)	Potential Annual Solar Generation (MWh)
1.	Physical Plant Services Building	1,62,883	1,29,600	792
2.	Activities and Recreation Center	4,42,235	1,18,800	726
3.	North Campus Parking Deck	5,21,441	81,000	495
4.	Electrical and Computer Engineering	2,38,390	33,480	399
5.	Armory	2,58,510	64,800	396
6.	Law Building	1,89,730	64,800	396
7.	Ikenberry Dining Hall	1,39,557	62,640	383
8.	Atkins Tennis Center	68,812	56,160	343
9.	Housing Food Stores	51,162	48,600	297
10.	Vet. Medicine Basic Sciences Building	2,59,413	48,600	297
11.	Loomis Laboratory of Physics	1,75,513	46,440	284
12.	Veterinary Teaching Hospital	2,33,703	44,280	270
13.	Abbott Power Plant	1,94,896	43,200	264
14.	Digital Computer Laboratory	1,94,280	43,200	264
15.	F-29 Parking Deck	2,53,669	43,200	264
16.	Micro and Nanotechnology Laboratory	1,47,347	43,200	264
17.	Newmark Civil Engineering Building	2,08,959	43,200	264
18.	Agricultural Engineering Sciences Building	1,06,019	41,040	251
19.	Seitz Materials Research Laboratory	1,23,151	33,480	204
20.	Rehabilitation Education Center (DRES)	42,080	30,240	185
21.	Huff Hall	1,82,536	28,080	171
22.	Krannert Art Museum	62,440	28,080	171
23.	Allen Residence Hall	1,57,023	27,000	165
24.	Chemical and Life Sciences Building	2,31,316	27,000	165
25.	Mechanical Engineering Building	1,00,518	27,000	165
26.	Mechanical Engineering Laboratory	1,51,860	27,000	165
27.	Natural Resources Studies Annex	65,416	27,000	165
28.	Plant Sciences Laboratory	1,00,848	27,000	165
29.	Timothy J. Nugent Hall	1,15,517	27,000	165
30.	Illini Union	3,05,130	25,920	158
31.	Institute for Genomic Biology	2,19,789	25,920	158
32.	Campus Recreation Center - East	1,04,575	24,840	152
33.	Ice Arena	51,676	24,840	152
34.	Oak Street Library	51,308	24,840	152
35.	Richard T. Ubben Basketball Complex	39,067	24,840	152
36.	Bousfield Hall	1,86,114	23,760	145
37.	Education Building	94,059	21,600	132
38.	Engineering Sciences Building	1,07,724	21,600	132
39.	Everitt Electricity & Computer Engineering Laboratory	1,24,246	21,600	132
40.	Foreign Languages Building	1,17,715	21,600	132
41.	Music Building	1,05,343	21,600	132
42.	Garage and Car Pool	27,395	20,520	125
43.	Business Instructional Facility	1,62,251	10,800	66

C. Architecture Review Committee's Analysis

	Building	Notes	Initial Review Comments by ARC
1.	Abbott Power Plant	Flat roof, a study was done by a senior design group with good information	O = Okay, has potential
2.	Activities and Recreation Center	Flat roof; hard to tell which portions are flat, this is a very rough estimate	O = Okay, has potential, there are some existing
3.	Ag Engineering Sciences Building	Flat roof	O = Okay, has potential
4.	Allen Residence Hall	Flat roof w/ connection to LAR	X = not recommended
5.	Armory	2200 m^2 flat roof, 4800 south facing curved dome roof	X = not recommended
6.	Atkins Tennis Center	Flat roof; Atkins Tennis Centery	O = Okay, has potential
7.	Bousfield Hall	Flat roof	O = Okay, has potential
8.	Business Instructional Facility	Additional solar energy generation planned	O = Okay, has potential
9.	Campus Recreation Center - East	1/2 South facing angled roof, 1/2 flat roof	x = not recommended
10.	Chemical and Life Sciences Building	Flat roof	O = Okay, has potential
11.	Digital Computer Laboratory	Flat roof, shading may be a problem with tiered roof levels	O = Okay, has potential
12.	Education Building	Flat roof	X = not recommended
13.	Electrical & Computer Engineering	Flat roof	O = Okay, already planned
14.	Engineering Sciences Building	Flat roof, potential north shading from trees	O = Okay, has potential
15.	Everitt Laboratory	Flat roof, already has solar up there	O = Okay, has potential
16.	F-29 Parking Deck	Large flat parking deck; see ECE Building parking deck plans	O = Okay, has potential
17.	Foreign Languages Building	Flat roof	X = not recommended
18.	Garage & Carpool	Flat roof	O = Okay, has potential
19.	Housing Food Stores	Flat roof	O = Okay, has potential
20.	Huff Hall	flat roof	X = not recommended
21.	Ice Arena	Flat roof	X = not recommended
22.	Ikenberry Dining Hall	Flat roof	O = Okay, has potential
23.	Illini Union	3/4 Flat roof, 1/4 south facing angled roof; access to angled roof may be difficult	X = not recommended
24.	Institute for Genomic Biology	Flat roof for a majority; appr. 300 m^2 angled south facing roof	O = Okay, has potential
25.	Krannert Art Museum	Flat roof; satellite images aren't great, hard to tell what roof looks like	X = not recommended
26.	Law Building	Flat roof	O = Okay, has potential
27.	Loomis Laboratory of Physics	Flat roof	O = Okay, has potential
28.	Mechanical Engineering Building	Flat roof	O = Okay, has potential
29.	Mechanical Engineering Laboratory	Flat roof portion	X = not recommended
30.	Micro and Nanotechnology Laboratory	Flat roof	O = Okay, has potential
31.	Music Building	Flat roof, may have the same issues as Krannert due to acoustics for some of the rooms	O = Okay, has potential
32.	Natural Resources Studies Annex	Flat roof; not pictured on map given	O = Okay, has potential

	Building	Notes	Initial Review Comments by ARC
33.	Newmark Civil Engineering Building	Flat roof, however with the raised middle section shading may be a problem on the perimeter	O = Okay, has potential in some areas
34.	North Campus Parking Deck	ECE Building is planning on using this already	O - Okay, there has been a study completed for this site
35.	Oak Street Library	Flat roof; Oak Street Library Facility	O = Okay, has potential
36.	Physical Plant Services Building	Flat roof	O = Okay, has potential
37.	Plant Sciences Laboratory	Flat roof on north side of greenhouses	O = Okay, has potential
38.	Rehabilitation Education Center	Flat roof	O = Okay, has potential
39.	Richard T. Ubben Basketball Complex	Flat roof	O = Okay, has potential
40.	Seitz Materials Research Laboratory	Flat roof, some shading	O = Okay, has potential
41.	Timothy J. Nugent Hall	Flat roof	O = Okay, has potential
42.	Vet. Medicine Basic Sciences Building	Flat roof	O = Okay, has potential
43.	Veterinary Teaching Hospital	Flat roof	X = not recommended

D. Building Rooftop Analysis

	Building	Type of Roof	Additional Comments
1.	Abbott Power Plant	Flat roof	East roof was redone 10-12 years ago; Center section has less sun
2.	Activities and Recreation Center	Flat roof; Metal deck	They have solar thermal now; Solar PV is a good idea; Some parts of the roof are 10-15 years old, however there are new parts (6 years old) which could definitely hold the panels.
3.	Ag Engineering Sciences Building	Flat roof	However not very new and therefore may not be suitable
4.	Allen Residence Hall	Flat roof	-
5.	Armory	2200 m^2 of flat roof, 4800 m^2 south facing curved dome roof	-
6.	Atkins Tennis Center	Flat roof	-
7.	Bousfield Hall	Flat roof; Metal deck	Good roof for solar installation; Brand new TPO by Housing
8.	Business Instructional Facility	Flat roof	Additional solar already planned therefore a good candidate
9.	Campus Recreation Center - East	Half angled and half flat	-
10.	Chemical and Life Sciences Building	Flat roof	-
11.	Digital Computer Laboratory	Flat roof; Metal deck	Shading may be a problem with the tiered roof levels; One section was re-roofed; Other parts are very old and require re-roofing
12.	Education Building	Flat roof	-
13.	Electrical & Computer Engineering	Flat roof	Already planning solar on rooftop therefore good candidate
14.	Engineering Sciences Building	Flat roof	Potential shading from trees in the North; Fairly new roof but has a lot of mechanical equipment on it
15.	Everitt Laboratory	Flat roof	Post construction maybe a good candidate in the future
16.	F-29 Parking Deck	Flat	Check plans for NCPD solar
17.	Foreign Languages Building	Flat roof	-
18.	Garage & Carpool	Flat roof	-
19.	Housing Food Stores	Flat roof	Roof barely keeps water away; Requires new roofing; Not a suitable option for solar
20.	Huff Hall	Flat roof	-
21.	Ice Arena	Flat roof	-
22.	Ikenberry Dining Hall	Flat roof; Metal deck	New roof therefore suitable to hold panels
23.	Illini Union	3/4 Flat; 1/4 south facing angled	For historic preservaion issues, not a good choice
24.	Institute for Genomic Biology	Majority flat roof; Metal deck	Rubber roof about 8-10 years old therefore suitable
25.	Krannert Art Museum	flat roof	-
26.	Law Building	Flat roof; Metal deck	Some areas are good, however some seem to be in a bad shape
27.	Loomis Laboratory of Physics	Flat roof	-

	Building	Type of Roof	Additional Comments
28.	Mechanical Engineering Building	Flat roof	Major remodelling and addition is in the pipeline
29.	Mechanical Engineering Laboratory	Flat roof	-
30.	Micro and Nanotechnology Laboratory	Flat roof	Has old and new sections mixed up, therefore not a good choice
31.	Music Building	Flat roof	May have similar issues like Krannert in terms of acoustics; Roof replacement in the pipeline therefore not a good option
32.	Natural Resources Studies Annex	Flat roof	However, granular therefore not recommended for solar
33.	Newmark Civil Engineering Building	Flat roof	Has mechanical equipment; the central raised section may cause shading issues
34.	North Campus Parking Deck	Flat	ECE building is planning to use already therefore a good option
35.	Oak Street Library	Flat roof; Metal deck	Rubber roof and in good shape therefore a good candidate
36.	Physical Plant Services Building	Flat roof	Decently good condition; could look at ARC's design of erecting a steel frame to hold solar thermal
37.	Plant Sciences Laboratory	Flat roof; Metal deck	Re-roofing may be required
38.	Rehabilitation Education Center	Flat roof	Fairly new roof; Shading from trees around maybe an issue
39.	Richard T. Ubben Basketball Complex	Flat roof; Metal deck	Fairly new roof (8-10 years old) and in good shape
40.	Seitz Materials Research Laboratory	Flat roof	ESCO project may use majority of the available roof therefore not a good option
41.	Timothy J. Nugent Hall	Flat roof; Metal deck	Good roof with Housing's new TPO
42.	Vet. Medicine Basic Sciences Building	Flat roof	LAC and SAC have new flat roofs which could be potential candidates for solar
43.	Veterinary Teaching Hospital	Flat roof	-

E. Buildings that made it to the Final List

To achieve the additional 4,200 MWh/year of additional solar energy on campus, the following buildings have been identified. The buildings on the list collectively have the potential of generating about 6,050 MWh/year. The list provided can collectively produce more solar energy than required by the iCAP goal for FY20.

However, when these buildings were identified, it was assumed that some buildings would not be willing to participate in the process. However, if we are able to install solar panels on all of the following buildings, we will be closer to our FY25 goal of generating 25,000 MWh/year of solar energy on campus.

	Building	Potential Annual generation (MWh)
1.	Additional solar on Business Instructional Facility	unknown
2.	North Campus Parking Deck (NCPD)	1,595
3.	Physical Plant Services Building	790
4.	Activities and Recreation Center	725
5.	Electrical and Computer Engineering	400
6.	Law Building	395
7.	Ikenberry Dining Hall	380
8.	Digital Computer Laboratory	265
9.	Abbott Power Plant	265
10.	Disability Resources & Educational Services	185
11.	Plant Sciences Laboratory	165
12.	Timothy J. Nugent Hall	160
13.	Institute for Genomic Biology	160
14.	Richard T. Ubben Basketball Complex	150
15.	Oak Street Library	150
16.	Bousfield Hall	145
17.	Garage and Carpool	125
	TOTAL	**6,055**

The next step was to meet with the building stakeholders to understand their stance, and whether they had any questions or concerns regarding retrofitting their buildings with solar panels. I presented to each of the building stakeholders with how I went about selecting their building and why it made it to the list.

Also, a new pilot tool by Google – Solar Savings Estimator was launched recently. I used this tool to get an idea of how shading on buildings could affect the solar energy generation through photovoltaic panels.

Money Savings through Solar Energy Generation

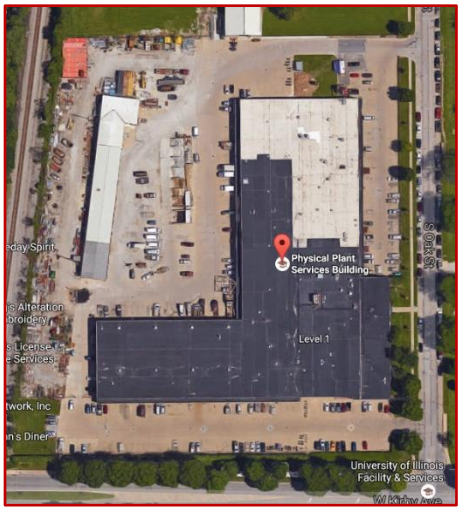
Currently, the average cost of producing solar energy is 12.2 cents per kWh of electric energy output. Based on this, and the 2016 energy consumption, monetary savings per year was calculated. This was simply multiplied by 25 to give an estimate of monetary savings for each building over the next 25 years.

	Building	Energy Consumption in 2016 (kWh)	Potential Solar Energy Generation (kWh/year)	$ Savings per year	$ Savings over the next 25 years
1.	Physical Plant Services Building	1,773,613	791,522	9,657	241,414
2.	Activities and Recreation Center	3,032,277	725,562	8,852	221,296
3.	North Campus Parking Deck	1,486,760	494,701	6,035	150,884
4.	Electrical and Computer Engineering	2,491,586	400,000	4,880	122,000
5.	Law Building	1,545,153	395,761	4,828	120,707
6.	Ikenberry Dining Hall	2,448,379	382,569	4,667	116,683
7.	Abbot Power Plant	unknown	263,841	3,219	80,471
8.	Digital Computer Laboratory	3,362,598	263,841	3,219	80,471
9.	Rehabilitation Education Center (DRES)	456,936	184,688	2,253	56,330
10.	Plant Sciences Laboratory	2,725,355	164,900	2,012	50,295
11.	Timothy J. Nugent Hall	2,094,930	164,900	2,012	50,295
12.	Institute for Genomic Biology	8,466,620	158,304	1,931	48,283
13.	Oak Street Library	1,686,741	151,708	1,851	46,271
14.	Richard T. Ubben Basketball Complex	890,400	151,708	1,851	46,271
15.	Bousfield Hall	1,409,036	145,112	1,770	44,259
16.	Garage and Car Pool	293,144	125,324	1,529	38,224
17.	Business Instructional Facility	1,195,196	65,960	805	20,118

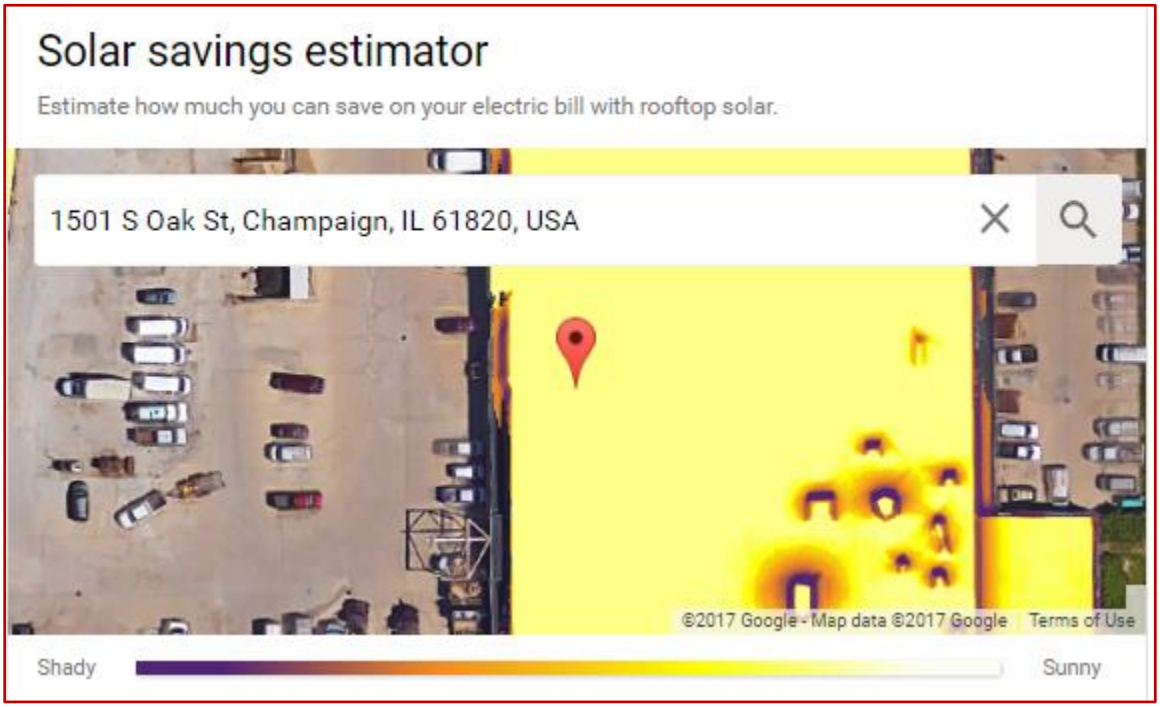
Meeting the Stakeholders

Physical Plant Services Building

- Meeting held on: August 3, 2016
- Meeting attended by:
    i. Michael James Larson
    ii. Kent V. Reifsteck
    iii. Peter W. Varney
    iv. Morgan Johnston
    v. Niharika Kishore
- Building GSF: 162,883
- Building rooftop available for solar generation (ft^2): 129,600
- Energy consumption in 2016 (MWh): 1,773
- Potential solar energy generation (MWh/year): 792
- Potential $ savings annually: $9,657

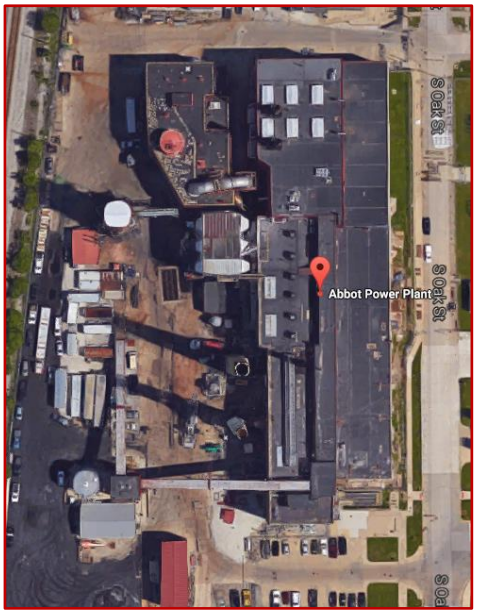


During the meeting, PPSB was more than willing to be considered to meet the iCAP goal. They felt that this would boost their image and that they would be able to successfully help the campus in achieving the campus' green goals. Also, PPSB saw significant energy and money savings resulting from solar power generation.



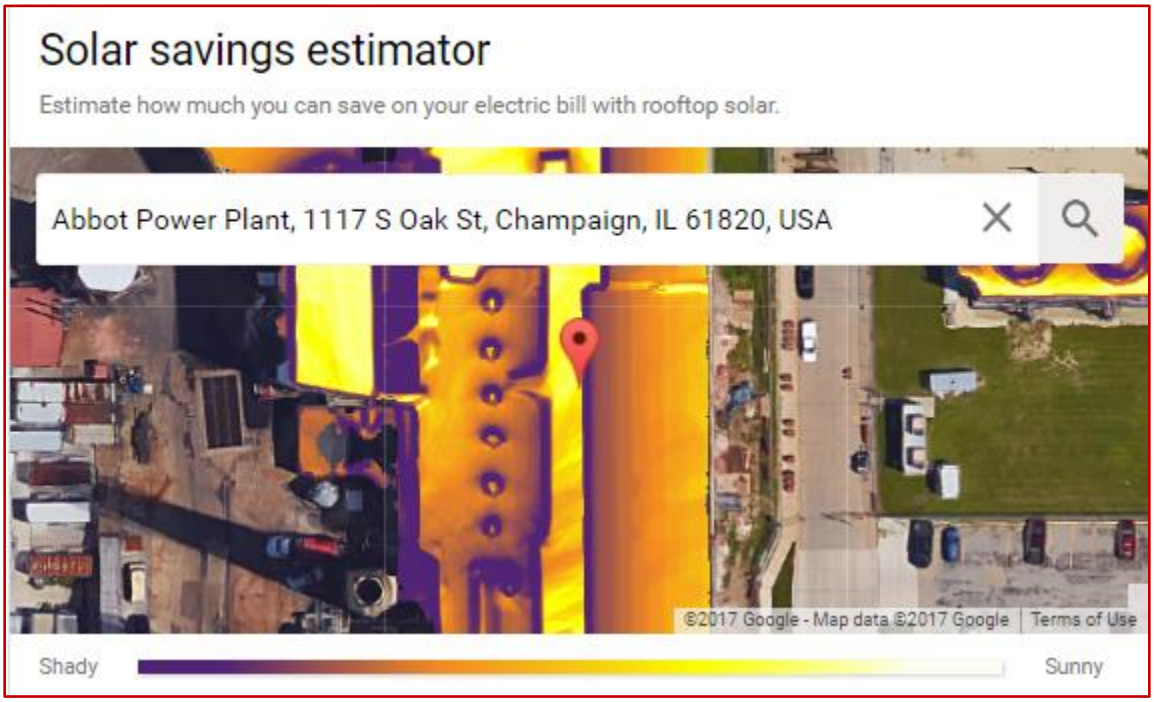
Meeting the Stakeholders

Abbot Power Plant



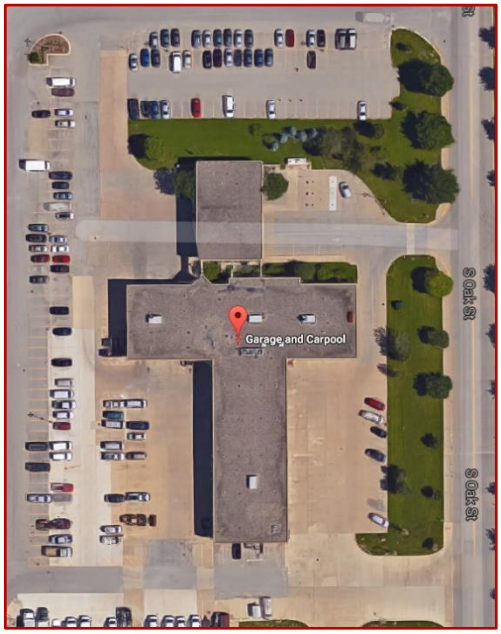
- Meeting held on: August 3, 2016
- Meeting attended by:
    i. Michael James Larson
    ii. Kent V. Reifsteck
    iii. Peter W. Varney
    iv. Morgan Johnston
    v. Niharika Kishore
- Building GSF: 194,896
- Building rooftop available for solar generation (ft^2): 43,200
- Energy consumption in 2016 (MWh): -283,688
- Potential solar energy generation (MWh/year): 264
- Potential $ savings annually: $3,219

Abbot Power Plant wanted to incorporate solar energy generation on their premises for quite some time but SSC refused to fund the project stating that they did not want to support a dirty energy producing coal power plant like Abbot and therefore, due to lack of funding Abbot had to drop the idea. They were more than happy when we approached them to participate in this process.



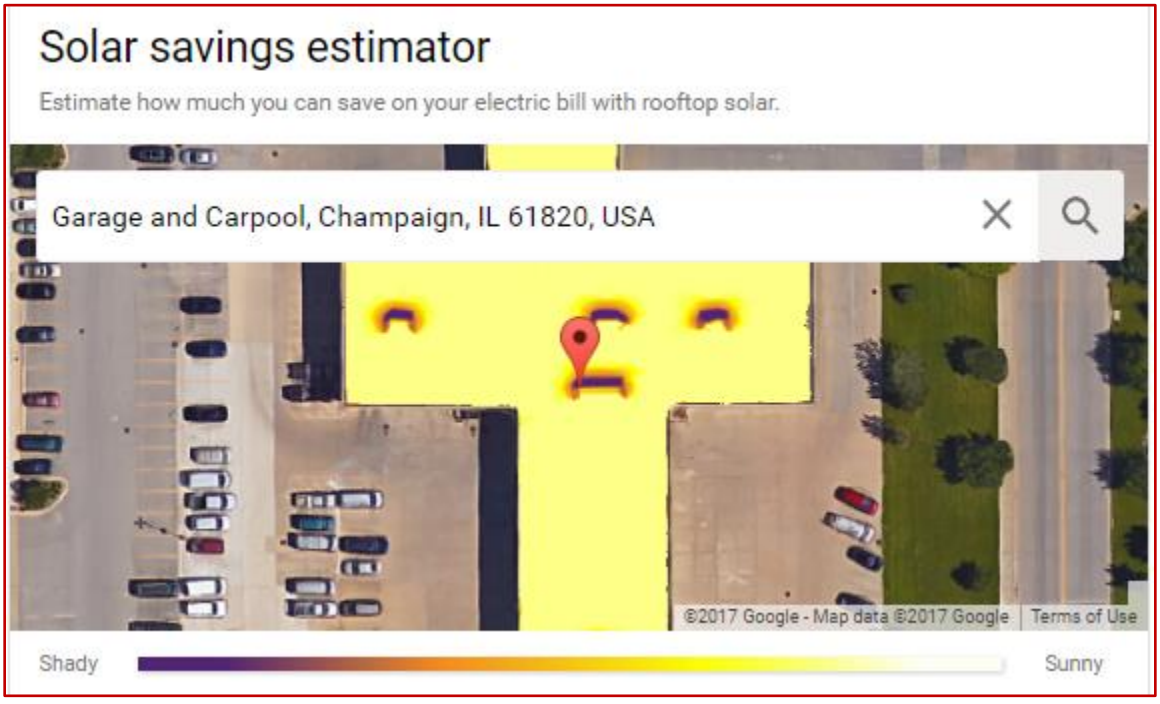
Meeting the Stakeholders

Garage and Carpool



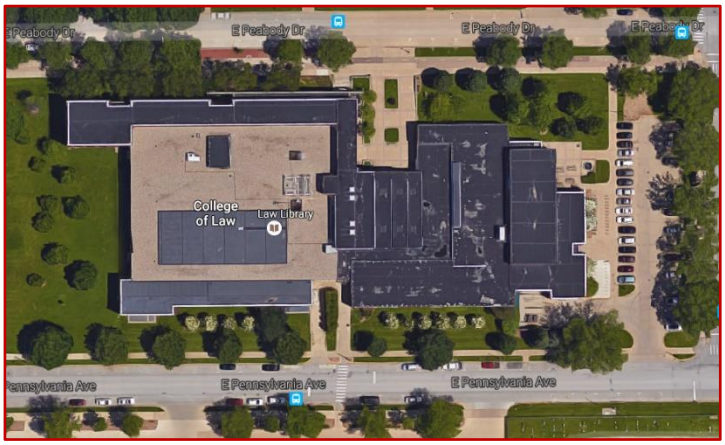
- Meeting held on: August 3, 2016
- Meeting attended by:
  i. Michael James Larson
  ii. Kent V. Reifsteck
  iii. Peter W. Varney
  iv. Morgan Johnston
  v. Niharika Kishore
- Building GSF: 27,395
- Building rooftop available for solar generation (ft^2): 20,520
- Energy consumption in 2016 (MWh): 293
- Potential solar energy generation (MWh/year): 125
- Potential $ savings annually: $1,529

Garage and Carpool shared the same sentiments as PPSB in terms of wanting to contribute their share towards reaching campus' green goals. Their rooftop is one of the
most favourable for retrofitting with solar panels since it is completely flat and does not have much mechanical equipment or shading.



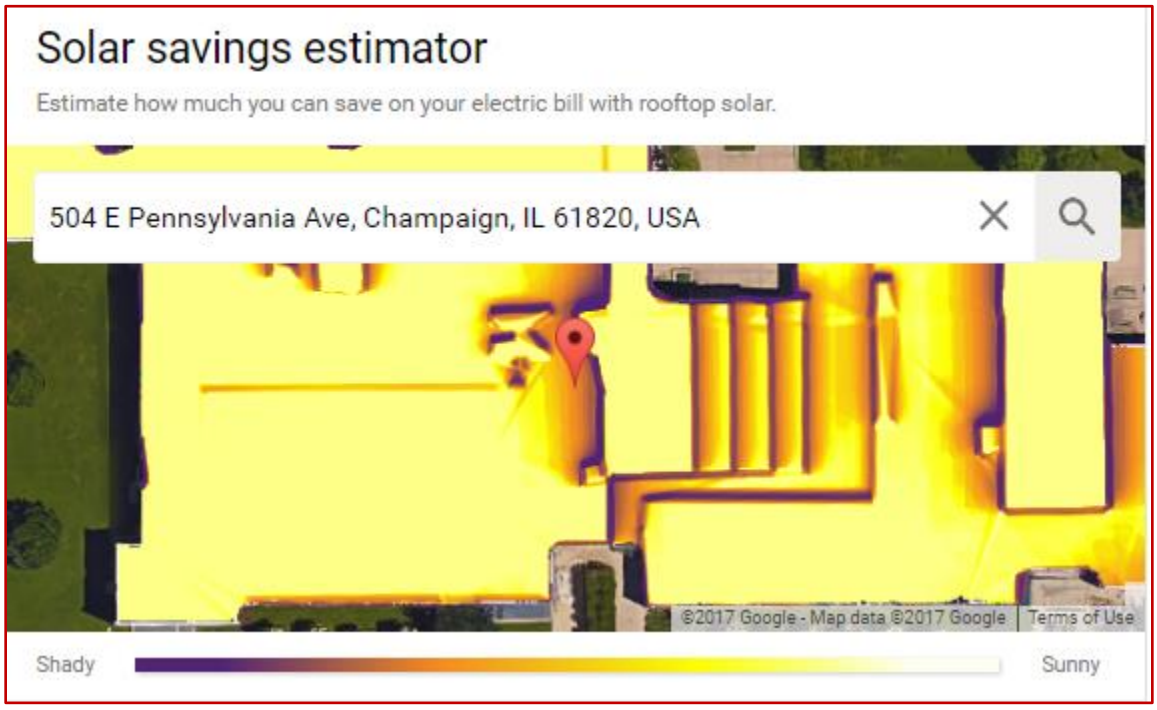
Meeting the Stakeholders

Law Building



- Meeting held on: August 5, 2016
- Meeting attended by:
  i. Greg Larson
  ii. Lori Beeson
  iii. John Rossi
  iv. Morgan Johnston
  v. Niharika Kishore
- Building GSF: 189,730
- Building rooftop available for solar generation (ft²): 64,800
- Energy consumption in 2016 (MWh): 1,545
- Potential solar energy generation (MWh/year): 395
- Potential $ savings annually: $4,828

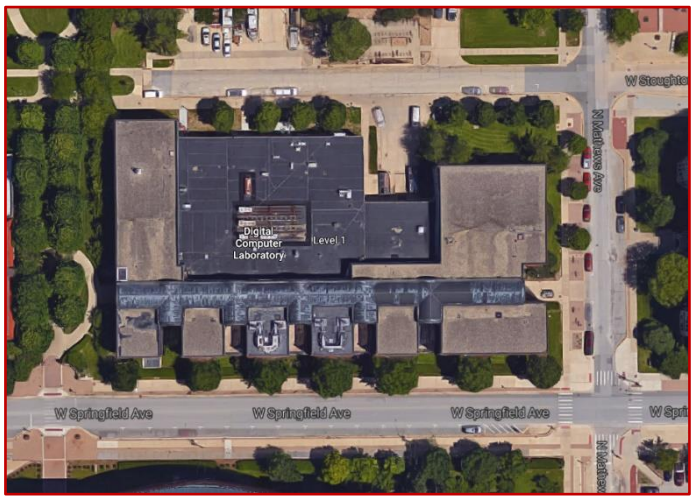
The Law Building stakeholders saw this as an opportunity to reduce their energy bills and sounded enthusiastic about retrofitting their rooftops with solar.



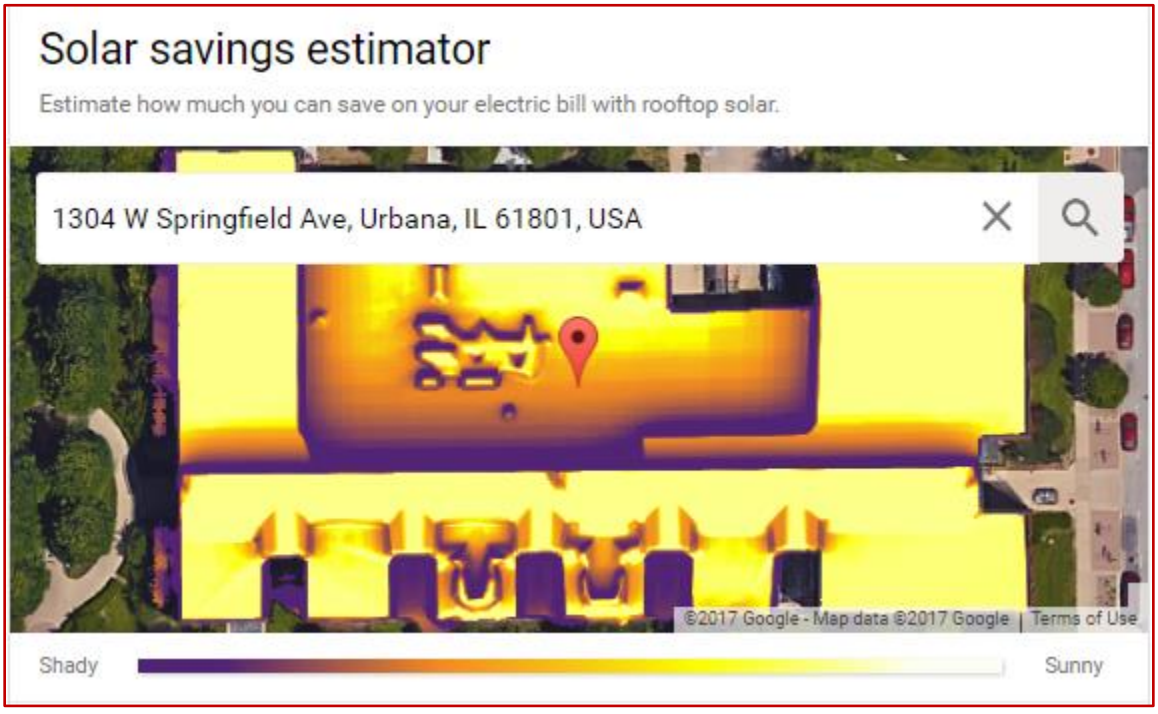
Meeting the Stakeholders

Digital Computer Laboratory

- Meeting held on: August 5, 2016
- Meeting attended by:
  i. Greg Larson
  ii. Lori Beeson
  iii. John Rossi
  iv. Morgan Johnston
  v. Niharika Kishore
- Building GSF: 194,280
- Building rooftop available for solar generation (ft²): 43,200
- Energy consumption in 2016 (MWh): 3,362
- Potential solar energy generation (MWh/year): 265
- Potential $ savings annually: $3,219



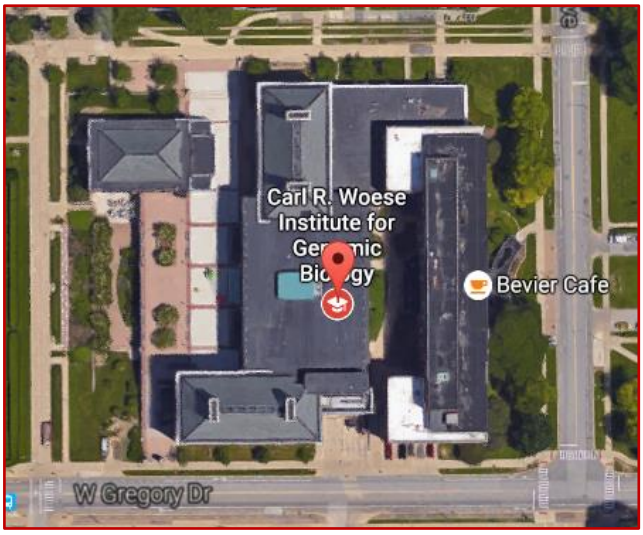
The Digital Computer Laboratory saw this as an opportunity for boosting their employee pride by generating at least some of its energy through clean and green sources.



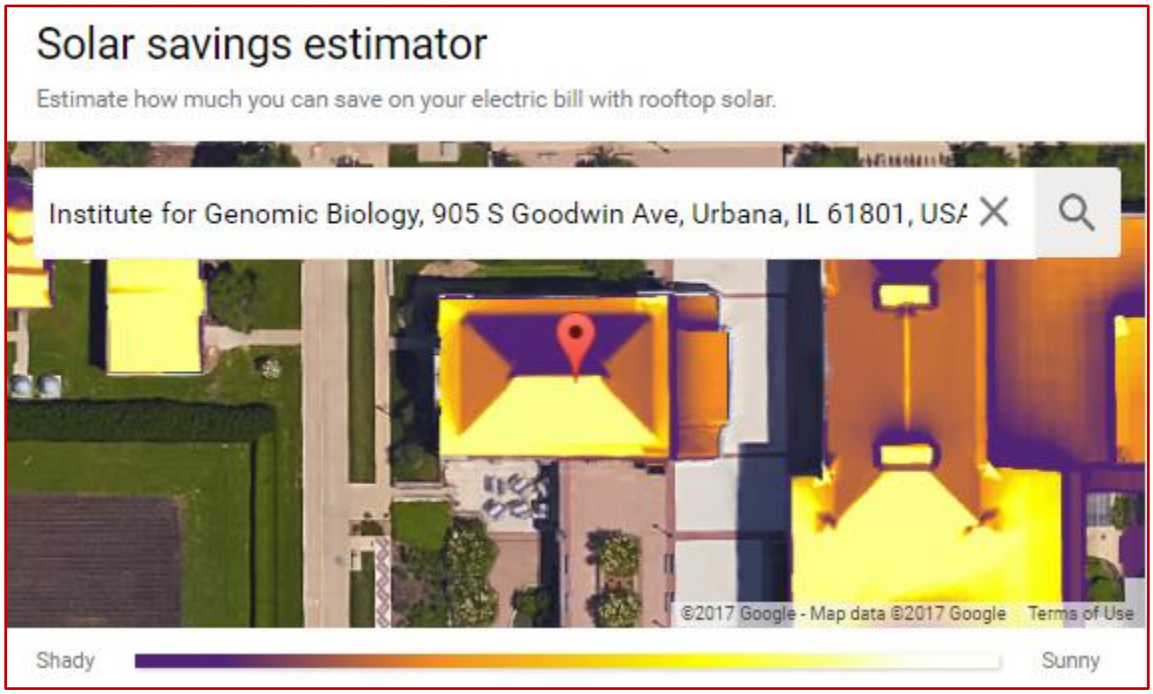
Meeting the Stakeholders

Institute for Genomic Biology

- Meeting held on: August 9, 2016
- Meeting attended by:
  i. Jesse Southern
  ii. Morgan Johnston
  iii. Niharika Kishore
- Building GSF: 219,789
- Building rooftop available for solar generation (ft²): 25,920
- Energy consumption in 2016 (MWh): 8,467
- Potential solar energy generation (MWh/year): 264
- Potential $ savings annually: $1,931

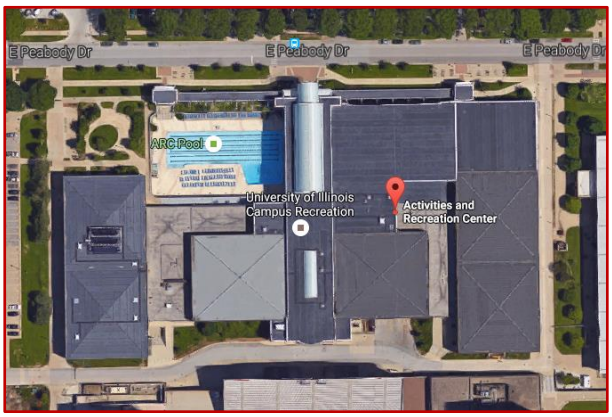


Institute for Genomic Biology building stakeholders saw this as a means to reduce their energy bills and therefore were ready to be included in this list.



Meeting the Stakeholders

Activities and Recreation Center



- Meeting held on: August 10, 2016
- Meeting attended by:
  i. Krissy Pettigrew
  ii. Terrence Elmore
  iii. Morgan Johnston
  iv. Niharika Kishore
- Building GSF: 442,235
- Building rooftop available for solar generation (ft²): 118,800
- Energy consumption in 2016 (MWh): 3,032
- Potential solar energy generation (MWh/year): 725
- Potential $ savings annually: $8,852

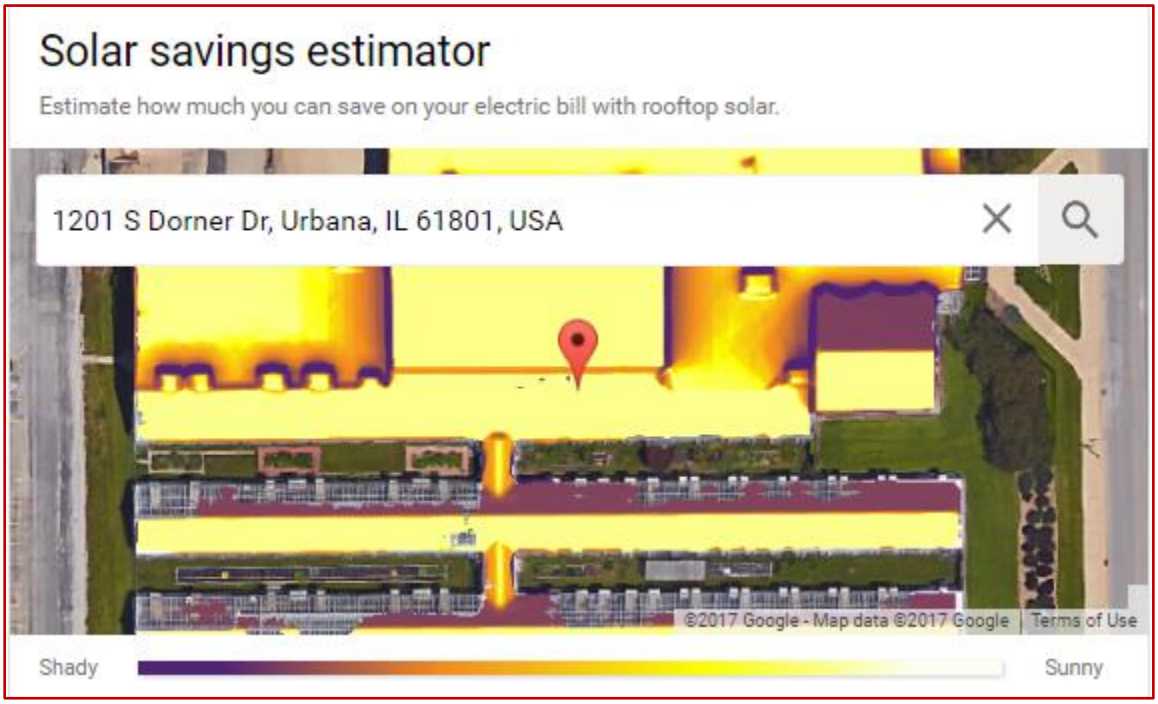
Activities and Recreation building stakeholders were probably the most enthusiastic of the lot since they pay their own bills and have a rather high energy consumption. They saw this project as a means of reducing their energy bills and requested that Campus Recreation Center East be included in the list as well.

Meeting the Stakeholders

Plant Sciences Laboratory

- Meeting held on: August 11, 2016
- Meeting attended by:
  i. Douglas Wolters
  ii. Darren Gentzler
  iii. Nathen Deppe
  iv. Morgan Johnston
  v. Niharika Kishore
- Building GSF: 100,848
- Building rooftop available for solar generation (ft^2): 27,000
- Energy consumption in 2016 (MWh): 2,725
- Potential solar energy generation (MWh/year): 165
- Potential $ savings annually: $2,012

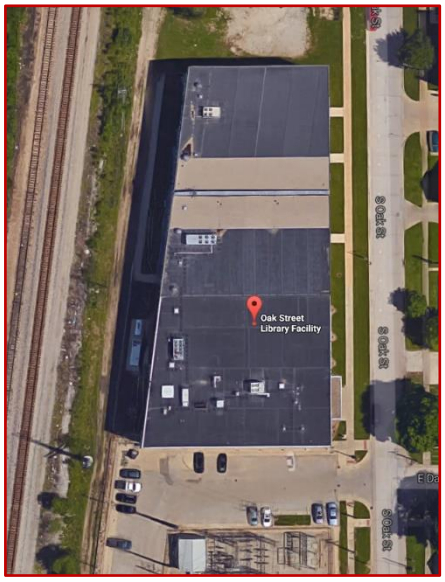
Plant Sciences Laboratory building stakeholders see this project as a marketing opportunity with direct benefits to the NRES and Crop Sciences Departments.



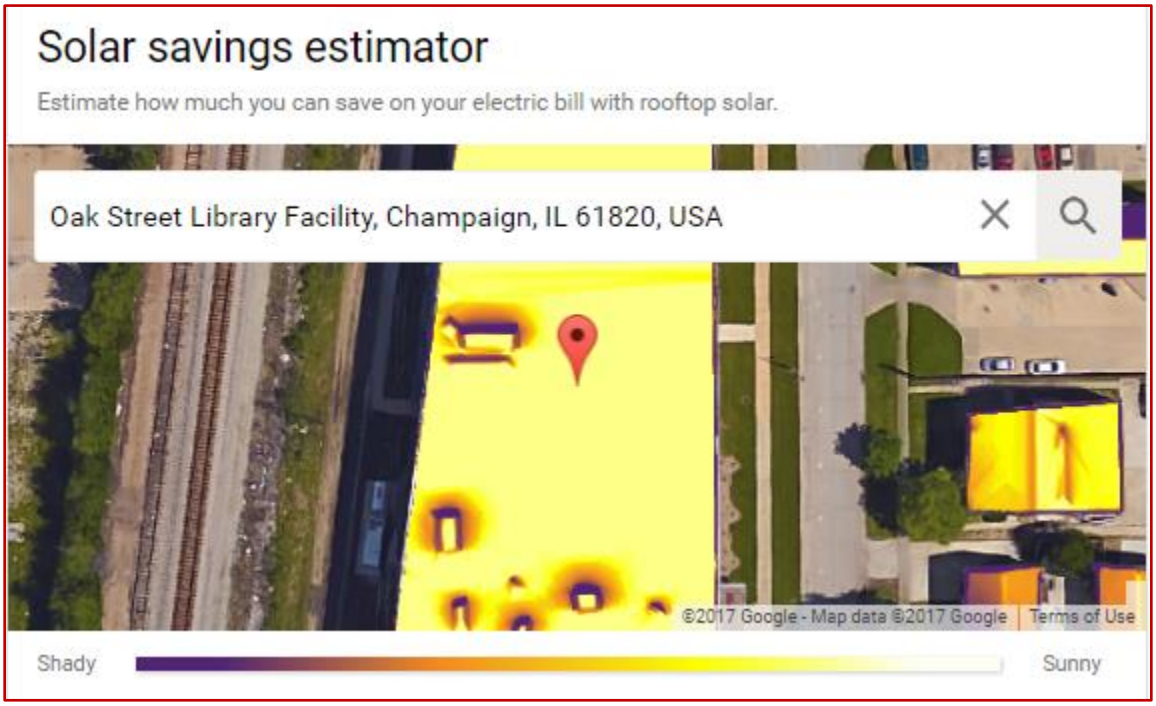
Meeting the Stakeholders

Oak Street Library

- Meeting held on: August 12, 2016
- Meeting attended by:
  i. Jeffrey Schrader
  ii. Lesli Lundquist
  iii. Morgan Johnston
  iv. Niharika Kishore
- Building GSF: 51,308
- Building rooftop available for solar generation (ft²): 24,840
- Energy consumption in 2016 (MWh): 1,687
- Potential solar energy generation (MWh/year): 152
- Potential $ savings annually: $1,851



The Oak Street Library building stakeholders see this as an opportunity to reducing their energy bills.

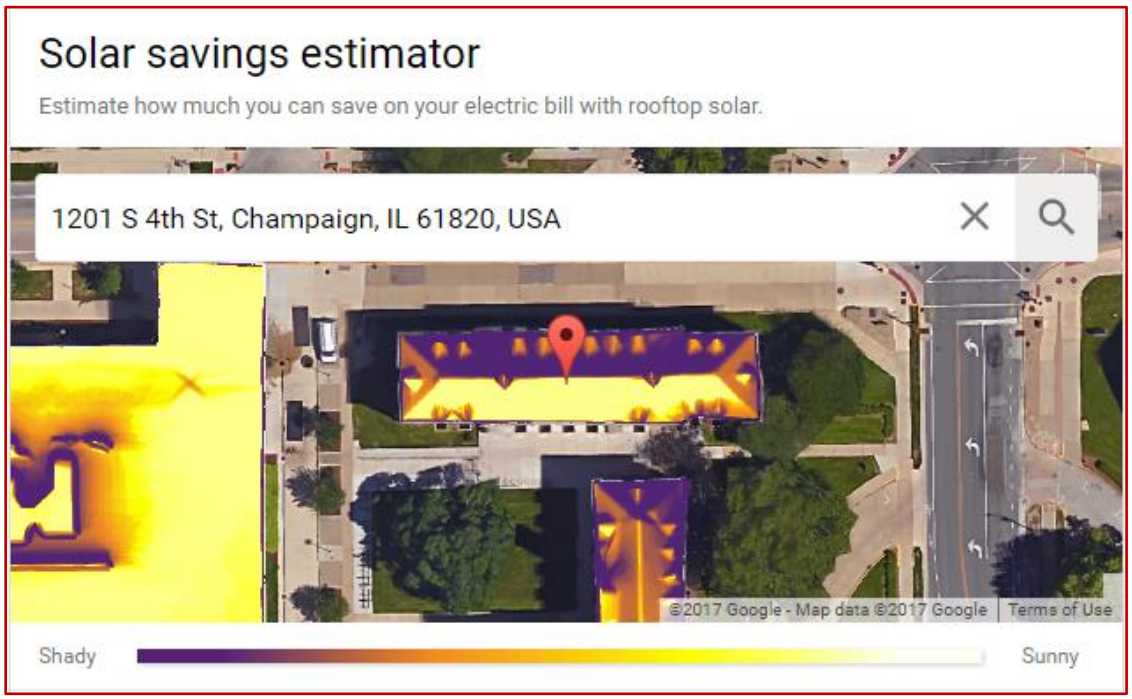


Meeting the Stakeholders

Ikenberry Dining Hall

- Meeting held on: September 22, 2016
- Meeting attended by:
  i. John Humlicek
  ii. Dennis Watson
  iii. Jeffery Riddle
  iv. Bryan Johnson
  v. Morgan Johnston
  vi. Niharika Kishore
- Building GSF: 139,557
- Building rooftop available for solar generation (ft²): 62,640
- Energy consumption in 2016 (MWh): 2,448
- Potential solar energy generation (MWh/year): 383
- Potential $ savings annually: $4,667

Housing was extremely enthusiastic about retrofitting their buildings with solar photovoltaic panels since they feel the student impression improves drastically with the presence of renewable energy on campus. They also feel that consuming at least a portion of green energy would boost their image which would help them significantly. The google solar calculator tool did not have an image for Ikenberry Dining Hall. However, in this image, we can see a part of it, adjacent to Lundgren Hall.



Meeting the Stakeholders

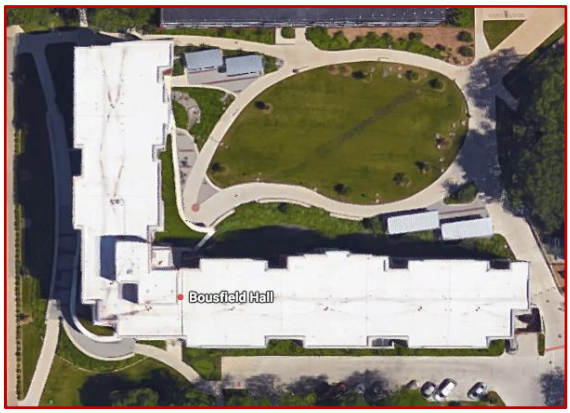
Timothy J. Nugent Hall

- Meeting held on: September 22, 2016
- Meeting attended by:
  i. John Humlicek
  ii. Dennis Watson
  iii. Jeffery Riddle
  iv. Bryan Johnson
  v. Morgan Johnston
  vi. Niharika Kishore
- Building GSF: 115,517
- Building rooftop available for solar generation (ft^2): 27,000
- Energy consumption in 2016 (MWh): 2,095
- Potential solar energy generation (MWh/year): 165
- Potential $ savings annually: $2,012

Housing was extremely enthusiastic about retrofitting their buildings with solar photovoltaic panels since they feel the student impression improves drastically with the presence of renewable energy on campus. They also feel that consuming at least a portion of green energy would boost their image which would help them significantly. The google solar calculator tool did not have any image for Timothy J. Nugent Hall.

Meeting the Stakeholders

Bousfield Hall

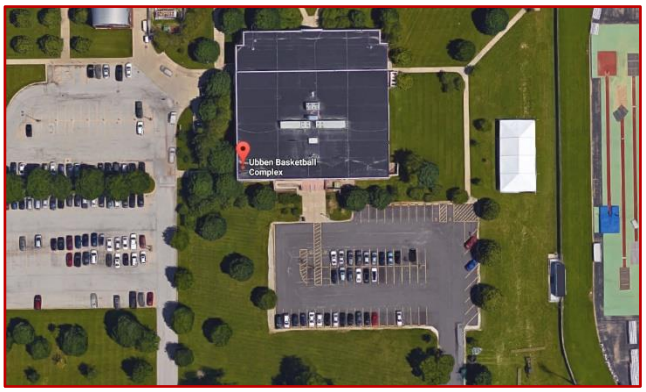


- Meeting held on: September 22, 2016
- Meeting attended by:
    i. John Humlicek
    ii. Dennis Watson
    iii. Jeffery Riddle
    iv. Bryan Johnson
    v. Morgan Johnston
    vi. Niharika Kishore
- Building GSF: 186,114
- Building rooftop available for solar generation (ft^2): 23,760
- Energy consumption in 2016 (MWh): 1,409
- Potential solar energy generation (MWh/year): 145
- Potential $ savings annually: $1,770

Housing was extremely enthusiastic about retrofitting their buildings with solar photovoltaic panels since they feel the student impression improves drastically with the presence of renewable energy on campus. They also feel that consuming at least a portion of green energy would boost their image which would help them significantly. The google solar calculator tool did not have any image for Bousfield Hall.

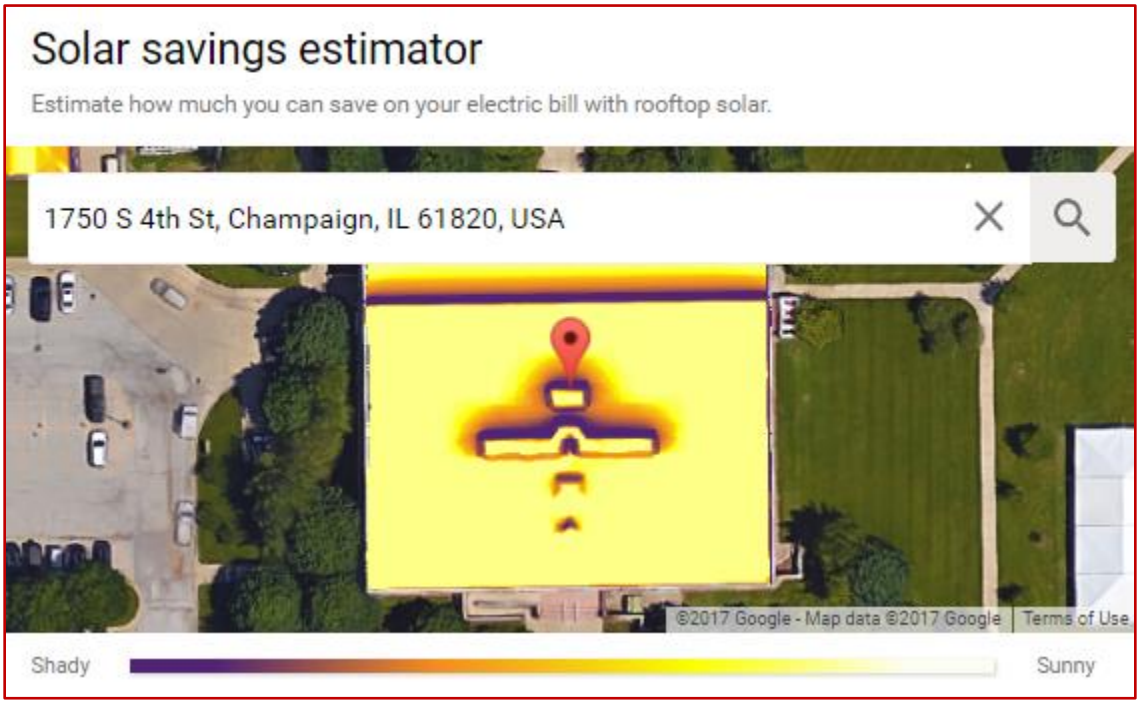
Meeting the Stakeholders

Richard T. Ubben Basketball Complex



- Meeting held on: November 4, 2016
- Meeting attended by:
  i. Brett Stillwell
  ii. Morgan Johnston
  iii. Niharika Kishore
- Building GSF: 39,067
- Building rooftop available for solar generation (ft²): 24,840
- Energy consumption in 2016 (MWh): 890
- Potential solar energy generation (MWh/year): 152
- Potential $ savings annually: $1,851

Richard T. Ubben Basketball Complex was also enthusiastic about incorporating solar energy as part of their energy consumption and felt that the student impression improves drastically with the presence of renewable energy. They also feel that consuming at least a portion of green energy would boost their image which would help them significantly and also reduce their energy bills.

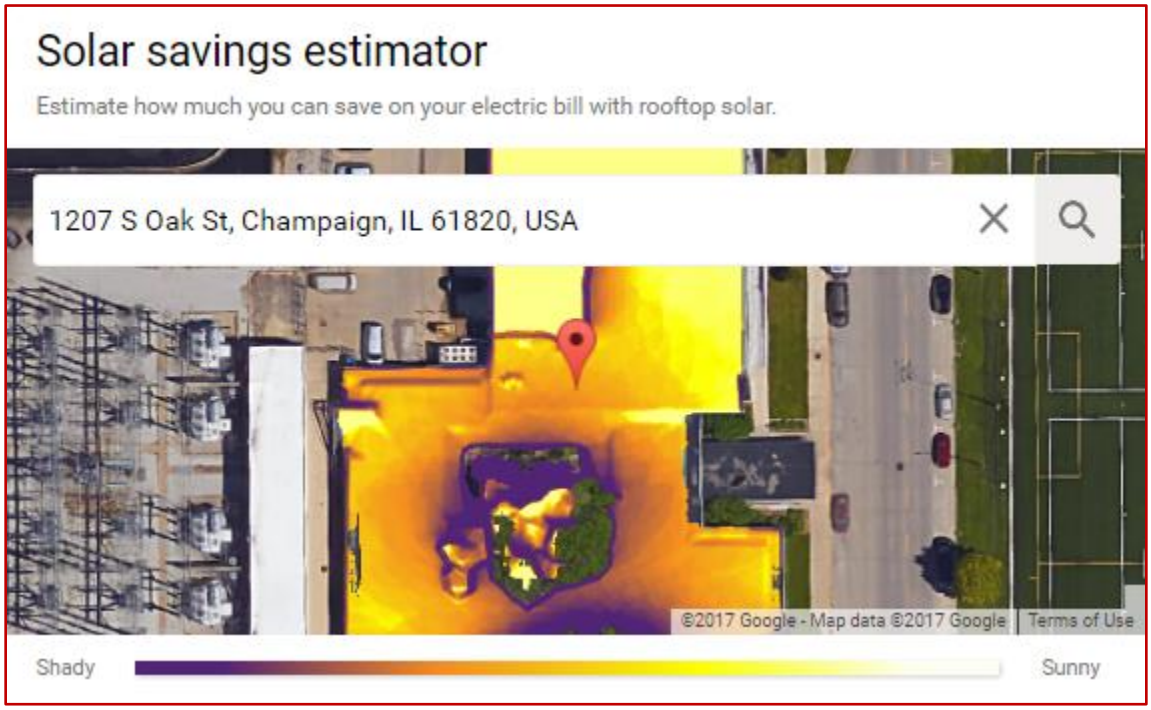


Meeting the Stakeholders

Rehabilitation Education Center (Disability Resources and Educational Services)

- Meeting held on: December 2, 2016
- Meeting attended by:
  i. Mylinda Granger
  ii. Morgan Johnston
  iii. Niharika Kishore
- Building GSF: 42,080
- Building rooftop available for solar generation (ft²): 30,240
- Energy consumption in 2016 (MWh): 457
- Potential solar energy generation (MWh/year): 185
- Potential $ savings annually: $2,253

DRES saw this as a means to reduce their energy bills and also support the campus in its pursuit of becoming carbon neutral as soon as possible.



An Analysis of Meetings with the Stakeholders

Primarily four questions were asked in each of the meetings to gage the interest and enthusiasm levels of the building stakeholders. The questions were also meant to understand their concerns and answer any questions that they may have. Following were the questions that were asked:

Q1. Can we include your building in this list to be considered for retrofitted with solar panels?

	BUILDING	ANSWER
1.	Additional solar on Business Instructional Facility	Yes
2.	NCPD roof & structure	Yes
3.	Physical Plant Services Building	Yes
4.	Activities and Recreation Center	Yes
5.	ECE rooftop	Yes
6.	Law Building	Yes
7.	Ikenberry Dining Hall	Yes
8.	Digital Computer Laboratory	Yes
9.	Abbott Power Plant	Yes
10.	Disability Resources & Educational Services	Yes
11.	Plant Sciences Laboratory	Yes
12.	Timothy J. Nugent Hall	Yes
13.	Institute for Genomic Biology	Yes
14.	Richard T. Ubben Basketball Complex	Yes
15.	Oak Street Library	Yes
16.	Bousfield Hall	Yes
17.	Garage and Carpool	Yes

Q2. What benefits do you see for your department from having rooftop solar?

	BUILDING	ANSWER
1.	Additional solar on Business Instructional Facility	Departmental luxury; Reduce energy bills
2.	NCPD roof & structure	Reduce energy bills
3.	Physical Plant Services Building	Support the iCAP
4.	Activities and Recreation Center	Reduce energy bills
5.	ECE rooftop	Step closer to net-zero; Reduce enery bills
6.	Law Building	Reduce energy bills
7.	Ikenberry Dining Hall	Student perception improves; At least generate some of their own energy
8.	Digital Computer Laboratory	Employee pride; shared ownership towards campus' sustainability goals
9.	Abbott Power Plant	Support the iCAP
10.	Disability Resources & Educational Services	Reduce energy bills; Contributing to the overall campus goals
11.	Plant Sciences Laboratory	Marketing benefits; Benefits to NRES and Crop Sciences
12.	Timothy J. Nugent Hall	Student perception improves; At least generate some of their own energy
13.	Institute for Genomic Biology	Reduce energy bills
14.	Richard T. Ubben Basketball Complex	Reduce energy bills; Improve student perception; More marketable to donors and students
15.	Oak Street Library	Reduce energy bills
16.	Bousfield Hall	Student perception improves; at least generate some of their own energy
17.	Garage and Carpool	Support the iCAP

Q3. What resources can you contribute towards this effort?

	BUILDING	ANSWER
1.	Additional solar on Business Instructional Facility	Will be funded by unit
2.	NCPD roof & structure	Will be funded by unit
3.	Physical Plant Services Building	--
4.	Activities and Recreation Center	Some monetory help; Human resources and involvement during RFP process
5.	ECE rooftop	Will be funded by unit
6.	Law Building	Human resource - willing to invest time, be involved in discussions, etc.
7.	Ikenberry Dining Hall	Finances can be reviewed on case-to-case basis; Want a more concrete plan to commit to any resources
8.	Digital Computer Laboratory	Human resource - willing to invest time, be involved in discussions, etc.
9.	Abbott Power Plant	Human resource - willing to invest time, be involved in discussions, etc.
10.	Disability Resources & Educational Services	Human resource - willing to invest time, be involved in discussions, etc.
11.	Plant Sciences Laboratory	Human resource - willing to invest time, be involved in discussions, etc.
12.	Timothy J. Nugent Hall	Finances can be reviewed on case-to-case basis; Want a more concrete plan to commit to any resources
13.	Institute for Genomic Biology	Human resource - willing to invest time, be involved in discussions, etc.
14.	Richard T. Ubben Basketball Complex	Financial resources as applicable
15.	Oak Street Library	Human resource - willing to invest time, be involved in discussions, etc.
16.	Bousfield Hall	Finances can be reviewed on case-to-case basis; Want a more concrete plan to commit to any resources
17.	Garage and Carpool	Human resource - willing to invest time, be involved in discussions, etc.

Q4. Are there building specific needs we should be aware of or concerns that need to be addressed?

	BUILDING	ANSWER
1.	Additional solar on Business Instructional Facility	New floor addition
2.	NCPD roof & structure	--
3.	Physical Plant Services Building	--
4.	Activities and Recreation Center	The roof is multi-floored i.e. varies in height; Require access for rof-repair work; There is a rubber+rock layer on the roof; The roof has previously caused some problems; There is HVAC equipment on the roof; The solar thermal in ARC has been over designed, therefore avoid this mistake with PV; Concerned with putting panels in the east side due to wooden floors
5.	ECE rooftop	Commissioned; Installation to be completed and generation to begin in Summer 2017
6.	Law Building	The roof is multi-floored i.e. varies in height; The lighter area is a relatively newer roof
7.	Ikenberry Dining Hall	The center has a steel structural unit - screen with rooftop units; Roof has differential elvels that might affect shading; Weston Hall shades some portions of the roof
8.	Digital Computer Laboratory	Potential roof damage from panels; How to lay new roofs; Downstream costs from the department; Roof belongs to F&S; New floor addition being planned; 2 storey HVAC leaks in the atrium space; Small sections are shaded
9.	Abbott Power Plant	Willing to put solar but SSC not willing to fund "coal/dirty fuel plant"
10.	Disability Resources & Educational Services	It is not a completely flat roof; Cannot put panels where trees shade the roof OR get rid of the trees on account for installin solar PV; Roof was redone in 2008 and is fairly new; A layer of dust typically forms on the cars due to the neighbouring power plant - could be a maintenance issue for the panels;
11.	Plant Sciences Laboratory	Protect the greenhouses from potential shading due to panels; Not a completely flat roof and therefore shading may occur; The building requires a new roof; Equipment being maintained on the roof requires access; Greenhouses are sprayed on in the spring - could this affect the panels?
12.	Timothy J. Nugent Hall	Has a concrete deck; Avoid the lower roofs for asthetic reasons; Only the top 3 sections are feasible for solar PV
13.	Institute for Genomic Biology	Solar PV installation should not shade the neighbouring murrow plots since the addition of a fourth floor was denied on account of shading over the murrow plots
14.	Richard T. Ubben Basketball Complex	There will be additions on the rooftop in the future to make the facility world-class; Design work may begin by 2020; may not be feasible for FY20 but definitely for FY25 iCAP plan; Possibility of solar thermal on the smaller facilities is a welcome idea
15.	Oak Street Library	Unaware of the long-term li15.brary stacks' plan; Avoid the roof hatch area; There are 16.parapets between vaults 2 and 3; HVAC equipment i17.s present on the roof; Is there a potential impact on neighbours?
16.	Bousfield Hall	Has green roofs and the whole roof can be used
17.	Garage and Carpool	--

Further Steps

As per the project time line, the next phase of this project is to seek funding. The Student Sustainability Committee (SSC) is one option for seeking funding since they would be willing to fund rooftop solar. Rooftop solar does not compete with other land-uses and is a fairly non-invasive process.

After seeking the funds required to finance this project, the RFP would need to be written and then formalized by FY18. As per the timeline, the installation process would need to be completed by FY19 so that 12,500 MWh/year of solar energy can be generated on campus by FY20.

The limitations of this project lie in the fact that only the large rooftop buildings were considered. This was consistent with the cost-effectiveness analysis of the project since retrofitting fewer buildings would cost less money in the long-run and also generate more energy, versus retrofitting multiple smaller buildings. However, a smaller capital investment may be easier to implement if multiple smaller buildings were retrofitted.

Nevertheless, if we need to achieve the goal by FY20, our best approach would be to implement this plan in the stated time-frame. This means that funding needs to be sought immediately, while parallelly writing the RFP in the months to come.

References

iCAP Portal, Institute for Sustainability, Energy, and Environment. University of Illinois at Urbana Champaign. American College and University Presidents' Climate Commitment (ACUPCC). Retrieved from https://icap.sustainability.illinois.edu/project/american-college-and-university-presidents-climate-commitment-acupcc

iCAP Portal, Institute for Sustainability, Energy, and Environment. University of Illinois at Urbana Champaign. Introduction to the iCAP. Retrieved from https://icap.sustainability.illinois.edu/

U.S. Green Buildings Council. Report on Buildings and Climate Change. Retrieved from http://www.eesi.org/files/climate.pdf

2015 iCAP – Illinois Climate Action Plan. University of Illinois at Urbana-Champaign. Retrieved from https://icap.sustainability.illinois.edu/files/project/2634/2015iCAPweb.pdf

Union of Concerned Scientists, Science for a healthy planet and safer world. Rooftop Solar Panels: Benefits, Costs, and Smart Policies. Retrieved from http://www.ucsusa.org/clean-energy/renewable-energy/rooftop-solar-panels-benefits-costs-policies#.WOhJ09LyvIU

iCAP Portal, Institute for Sustainability, Energy, and Environment. University of Illinois at Urbana Champaign. Renewable Energy Projects. Retrieved from http://icap.sustainability.illinois.edu/collections/renewable-energy-projects

When Will Rooftop Solar be Cheaper Than the Grid? U.S. News. March 31, 2016. Retrieved from https://www.usnews.com/news/articles/2016-03-31/when-will-rooftop-solar-be-cheaper-than-the-grid

Appendix – List of 2015 iCAP objectives

Energy Conservation and Building Standards objectives:

1) Maintain or reduce the campus gross square footage relative to the FY10 baseline.
2) Identify the highest achievable energy standards for new buildings and major renovations, and incorporate these into the campus facility standards by the end of FY16.
3) Strengthen centralized conservation efforts focusing on building systems to achieve a 30% reduction in total campus building energy use by FY20. This includes meeting LED Campus commitments.
4) Engage and incentivize the campus community in energy conservation, including a comprehensive energy conservation campaign, with at least 50% of units participating by FY20.

Energy Generation, Purchasing, and Distribution objectives:

5) The Energy Generation, Purchasing, and Distribution SWATeam, in collaboration with Facilities & Services and topical Consultation Groups, will lead an exploration of options for 100% clean campus energy during FY16 and submit recommendations through the formal sustainability process.
6) Expand on-campus solar energy production. By FY20, produce at least 12,500 MWh/year, and by FY25 at least 25,000 MWh, from solar installations on campus property. These targets represent 5% and 10% of our expected 2050 electricity demand, respectively.
7) Expand the purchase of clean energy. By FY20, obtain at least 120,000 MWh, and by FY25 at least 140,000 MWh from low-carbon energy sources. These targets represent 48% and 56% of our expected 2050 electricity demand, respectively.
8) Offset all emissions from the National Petascale Computing Facility (and other successor facilities) by the conclusion of the current period of National Science Foundation support.

Transportation objectives:

9) Reduce air travel emissions from a new FY14 baseline by 25% by FY20, 50% by FY25, and 100% by FY30.
10) Reduce emissions from the Urbana-Champaign campus fleet by 20% for departmentally-owned and 10 2015 Illinois Climate Action Plan (iCAP) carpool vehicles by FY20.
11) Conduct a detailed study by the end of FY17 to develop scenarios for complete conversion of the campus fleet to renewable fuels.
12) Reduce the percentage of staff trips made using single-occupancy vehicles from 65% to 55% by FY20, 50% by FY25, and 45% by FY30.
13) Implement the Campus Bike Plan on the schedule noted in that plan. Notable deadlines include full implementation of new bikeway facilities by FY25, bike parking within 150 feet of every building in the core of campus by FY20, and bike rentals by FY20.
14) Appropriately staff sustainable transportation efforts, especially through the hiring of an Active Transportation Coordinator.

Water and Stormwater objectives:

15) Obtain and publicize more granular water use data by FY16, including water quantity and quality data where available.

16) Improve the water efficiency of cooling towers by limiting the amount discharged to sewer to less than 20% of water intake for chiller plant towers, and less than 33% for stand-alone building towers, by FY20.
17) Perform a water audit to establish water conservation targets — and determine upper limits for water demand by end-use — for incorporation into facilities standards by FY16.
18) Inventory and benchmark campus' existing landscape performance by FY17.
19) Through an open solicitation process, implement at least four pilot projects to showcase the potential of water and/or stormwater reuse by FY20, with the objective of implementing a broader program by FY25.
20) Investigate the water quality impacts of stormwater runoff and potential ways to reduce stormwater pollutant discharges by FY18.

Purchasing, Waste, and Recycling objectives:

21) By FY17, environmental standards will be applied to purchases of office paper, cleaning products, computers, other electronics, and freight/package delivery services. At least 50% of purchases in these categories will meet campus standards by FY20, and 75% by FY25.
22) Reduce municipal solid waste (MSW) going to landfills. This involves reducing nondurable goods purchases, effectively reusing materials, and recycling. In the latter category, campus will increase the diversion rate of MSW to 45% by FY20, 60% by FY25, and 80% by FY35, while also increasing the total diversion rate to 90% by FY20 and 95% by FY25. MSW sent to landfills should decline to 2,000 tons annually by 2035.
23) Utilize landfills with methane capture.
24) Appropriately staff Zero Waste efforts through the hiring of a full-time Zero Waste Coordinator.

Agriculture, Land Use, Food, and Sequestration objectives:

25) Perform a comprehensive assessment of GHG emissions from agricultural operations, and develop a plan to reduce them, by the end of FY16.
26) Design and maintain campus landscapes in a more sustainable manner; expand the specification of sustainable plantings in campus landscaping standards, and develop and implement a tree care plan by FY16 and an integrated pest management program by FY17.
27) Incorporate sustainability principles more fully into the Campus Master Plan.
28) Implement a project that examines the food service carbon footprint for Dining and other on campus food vendors, while increasing local food procurement to 40% by FY25.
29) Increase carbon sequestration in campus soils by determining the sequestration value of existing plantings and identifying locations for additional plantings, with a specific objective of converting at least 50 acres of U of I farmland to agroforestry by FY20.
30) Reduce nitrates in agricultural runoff and subsurface drainage by 50% from the FY15 baseline by FY22.

Carbon Offsets objectives:

31) By the end of FY16, conduct a Request for Proposals process for verified carbon offsets — and undertake the first campus purchase of offsets.
32) By the end of FY17, develop an administrative mechanism to enable campus units to voluntarily purchase carbon offsets.
33) By the end of FY18, develop a program of local or regional mission-linked verified carbon offsets, so that our purchases of offsets will also support our institutional missions.

34) By FY20, utilize offsets to meet all iCAP emissions targets that have not been met by direct emission reductions.

Financing objectives:

35) By the end of FY16, develop criteria and a review process for the iCAP Working Group to allocate funding for feasibility studies of SWATeam-recommended sustainability projects and initiatives, using funds provided by campus administration and other sources.
36) By the end of FY16, increase the size of the Revolving Loan Fund (RLF) to a level commensurate with our aspirational peers, expand the reach of the Fund, and increase the use of Energy Performance Contracting.
37) By the end of FY16, identify the amount of funds that are available across campus for projects that do not offer a rapid financial payback, but which are nevertheless important for improving campus sustainability, and identify options to increase that amount annually.
38) By the end of FY16, evaluate the feasibility of internally putting a price on carbon emissions.

Curricular Education objectives:

39) Offer an undergraduate minor in sustainability, starting with about 20 students in FY16, that will provide in-depth learning about the three dimensions of sustainability and enable students to make connections between the different disciplines to solve problems related to sustainability.
40) Provide opportunities for undergraduate students to obtain research and practical experience by participating in independent study projects on sustainability topics.
41) Add at least five new sustainability-focused courses by FY20.

Outreach objectives:

42) Support and communicate about co-curricular student sustainability programs.
43) Strengthen and communicate about sustainability outreach programs. Specifically, at least half of the full-time campus staff will be participating in the Certified Green Office Program by FY20.
44) Organize and promote three major sustainability events on campus each year: Earth Week, Campus Sustainability Week, and the iSEE Congress.

Research objectives:

45) Create a hub for the sustainability community: to develop a comprehensive online gateway for faculty, staff, students, potential donors, and all interested parties to find information about sustainability research, education, outreach, initiatives, and operations.
46) Build connections: to bring together scholars from across campus to encourage collaboration, and to enhance research endeavors.
47) Foster “actionable” research: to encourage and support research that provides real-world solutions to society’s grand challenges in sustainability, energy and the environment. iSEE research themes are broken into five categories: Climate Solutions, Energy Transitions, Secure and Sustainable Agriculture, Sustainable Infrastructure, and Water and Land Stewardship.